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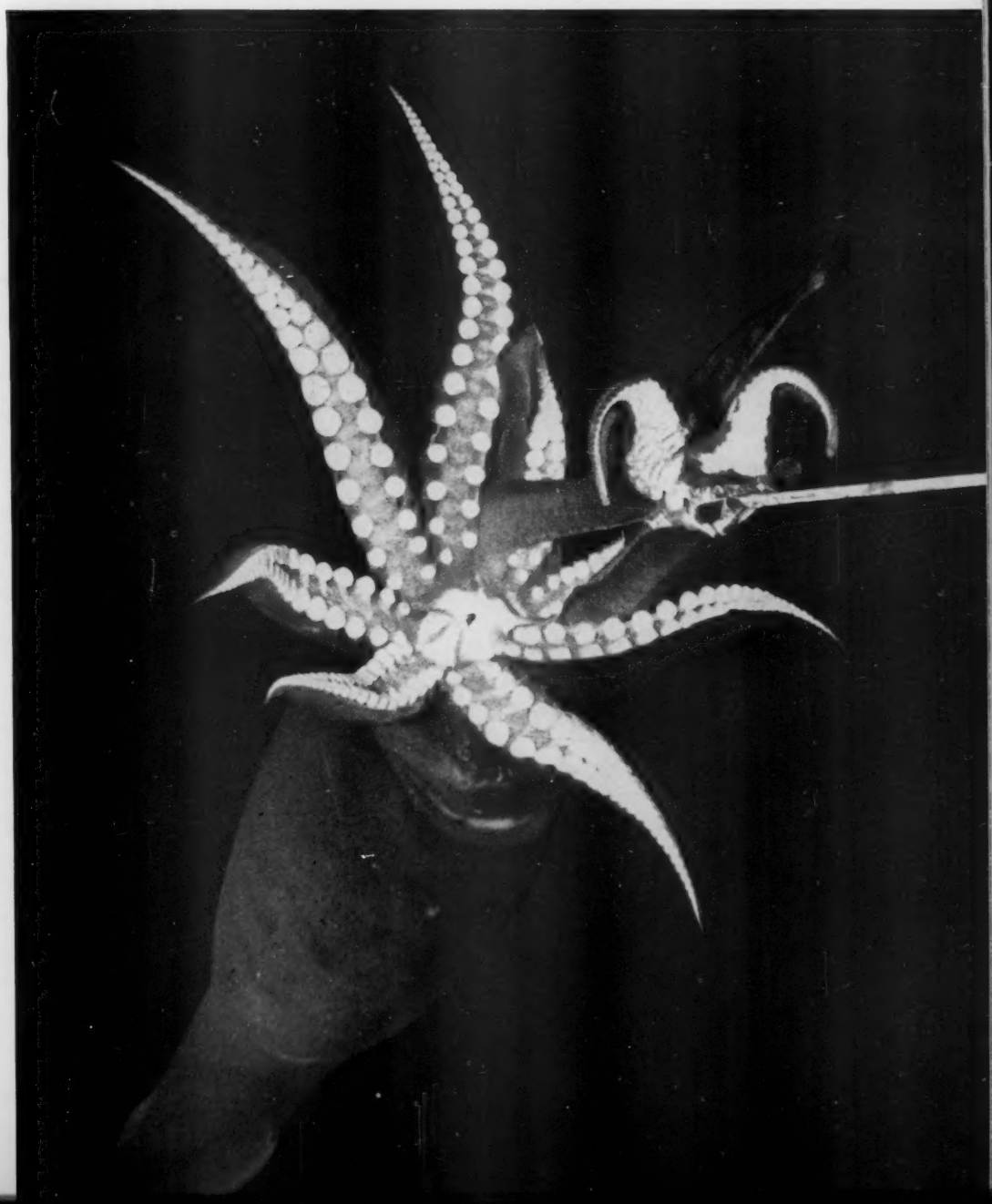
SCIENCE

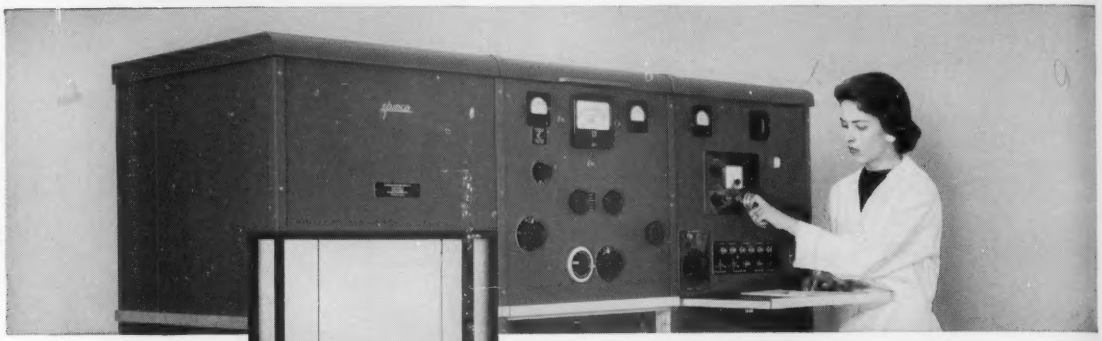
27 May 1960
Vol. 131, No. 3413

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



New Methods Extend the Usefulness of the Ultracentrifuge

Recent studies by research scientists have further increased the uses of the Analytical Ultracentrifuge for measuring molecular weights and purity of viruses, enzymes, proteins, polymers and a variety of organic and inorganic molecules. Here are four new developments as reported in the technical literature.



Interacting Systems

Kegeles and Rao at Clark University have measured the molecular weights of chemically reacting systems in the ultracentrifuge cell using the Archibald "approach-to-equilibrium" method. Studying the enzyme system alpha-chymotrypsin, they showed it to be present in the ultracentrifuge cell as an equilibrium mixture of monomers, dimers, and trimers. This is an extension of previous work which showed that the Archibald method applies to polydisperse non-ideal solutions, as well as to monodisperse ideal solutions.

Improved Accuracy

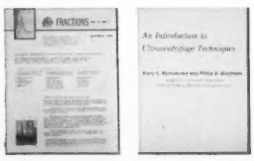
Trautman, at New York's Rockefeller Institute for Medical Research, showed that the accuracy of the Archibald method can be improved by more precisely locating the position of the meniscus on the ultracentrifuge photographic plate. He made a detailed study of the optical fine structure at the meniscus, and used a special optical aligning procedure with a mirror in the ultracentrifuge cell.

Simplified Measurements

At Stockholm's Nobel Medical Institute, Ehrenberg reports a simplified approach-to-equilibrium method which makes measurements from the schlieren curve easier. He runs the ultracentrifuge fast enough for a peak to begin forming at the meniscus so that the schlieren curve is parallel with the baseline and no extrapolation is necessary. His measurements of molecular weight and diffusion constants agree closely with those by other methods.

Rapid Equilibrium

Van Holde and Baldwin at the University of Wisconsin have used short liquid columns to achieve complete sedimentation equilibrium in a fraction of the time previously required. Using liquid columns of only 3 mm, they report equilibrium with sucrose in 3½ hours, and with a 1 mm column in only 30 minutes. In addition, the authors report that measurements during approach-to-equilibrium permit calculation of a diffusion coefficient.



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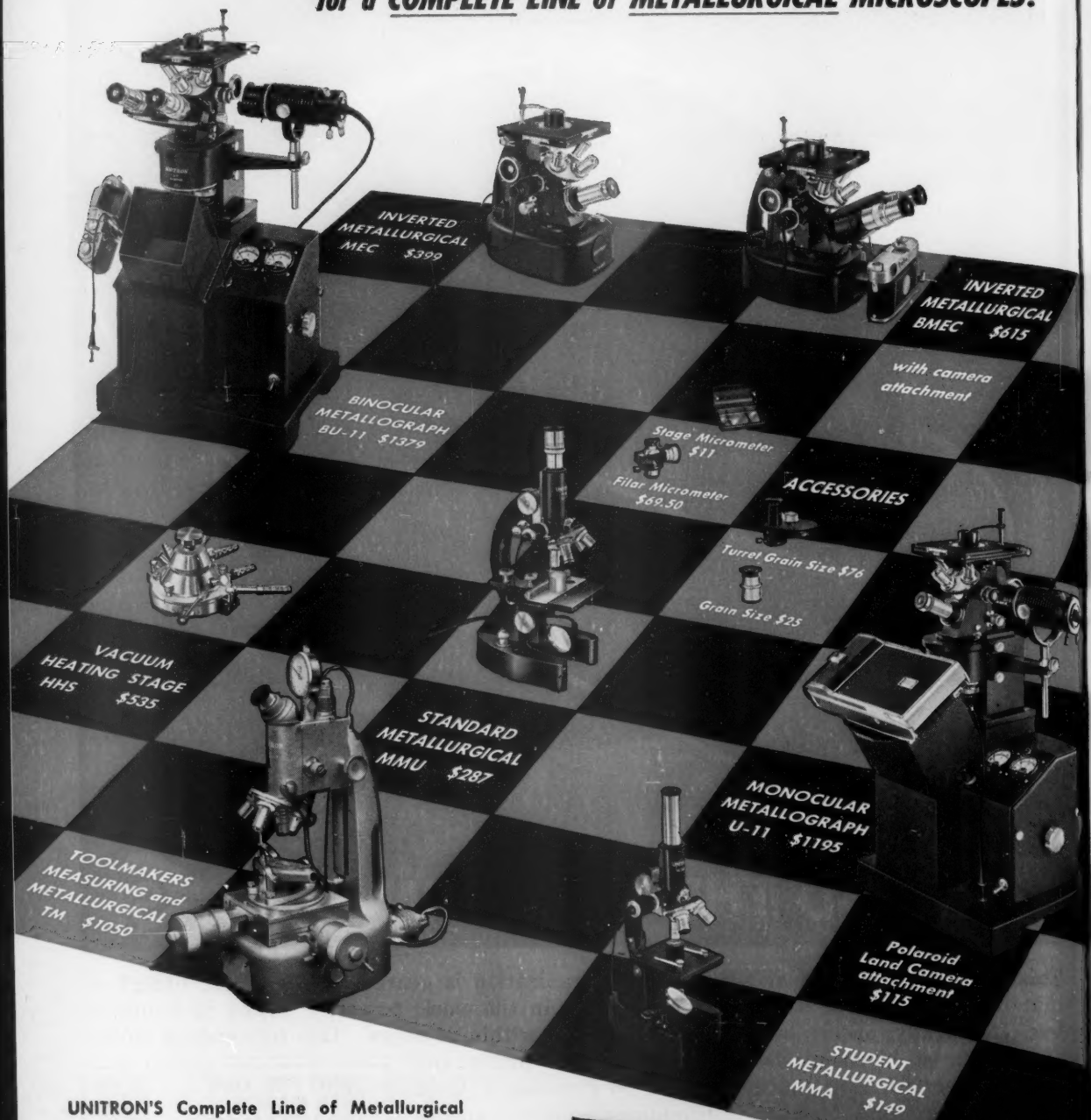

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Cover Photograph of oceanic squid at a depth of 700 meters. This picture was taken automatically as the squid pulled on a baited hook (lower center) attached to a deep-sea camera. Such photographs have given information about the distribution of squid with depth. This squid is about 3 feet long. [A. S. Laughton, National Institute of Oceanography, Wormley, Surrey, England]

Flames swept across the open plains as the Mongol hordes ran in terror from the "arrows of flying fire". When the smoke had cleared the Chinese had won the battle of Pienking with the first rocket.

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HAROLD S. BLACK, LAMME MEDALIST

A MAN WINS A MEDAL... AND STRENGTHENS A PHILOSOPHY

The search for the "hitherto unattainable" sometimes ends in strange places.

For years Bell Laboratories engineer Harold S. Black pondered a problem: how to rid amplifiers of the distortion which unhappily accumulated as signal-transmission paths were made longer and amplifiers were added. There had been many approaches but all had failed to provide a practical answer.

Then one day in 1927 the answer came—not in a research laboratory, but as he traveled to work on the Lackawanna Ferry. On a newspaper, Mr. Black jotted down those first exciting calculations.

Years later, his *negative feedback principle* had revolutionized the art of signal amplification. It is a principal reason why telephone and TV networks can now blanket the country, the transoceanic cable is a reality, and military radar and missile-control systems are models of precision.

For this pioneer achievement, and for numerous other contributions to communications since then (some 60 U. S. patents are already credited to him), Mr. Black received the 1957 Lamme Medal from the American Institute of Electrical Engineers. He demonstrated that the seemingly "unattainable" often *can* be achieved, and thus strengthened a philosophy that is shared by all true researchers.

He is one of many Bell Telephone Laboratories scientists and engineers who have felt the challenge of telephony and have risen to it, ranging deeply into science and technology. Numerous medals and awards have thus been won. Two of these have been Nobel Prizes, a distinction without equal in any other industrial concern.

Much remains to be done. To create the communication systems of the future, we must probe deeper still for new knowledge of Nature's laws. We must continue to develop new techniques in switching, transmission and instrumentation for every kind of information-bearing signal. As never before, communications offer an inspiring challenge to creative men.

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27 May 1960, Volume 131, Number 3413

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Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts and illustrations, see *Science* **125**, 16 (4 Jan. 1957).

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Annual subscriptions: $8.50; foreign postage, $1.50; Canadian postage, 75¢. Single copies, 35¢. Cable address: Advancesci, Washington.

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Risk and Benefit

In any legislation affecting public health the possible risks must be considered in relation to the possible benefits, and when the risks cannot be determined with certainty, reasonable and well-informed men may disagree about the best course to be followed. One approach is to avoid risk, however slight, entirely. This is the course that has been followed for food additives since the Delaney proviso of the Amendment of the Food, Drug, and Cosmetic Act of 1958 went into effect. The proviso states that "no additive shall be deemed to be safe if it is found to induce cancer when ingested by man or animal . . . ."

Secretary Flemming of the Department of Health, Education, and Welfare, acting under this amendment, barred the sale of cranberries that had been sprayed with aminotriazole, and of fowl that had been treated with stilbestrol. He now proposes that the same proviso be extended to the companion bills pending before the House and Senate (H.R. 7624 and S. 2197), which will "authorize the use of suitable color additives in or on foods, drugs, and cosmetics, in accordance with regulations prescribing the conditions (including maximum tolerances) under which such additives may be safely used."

In support of his recommendation Flemming cites several sources, among them the statement by the Food Protection Committee of the National Academy of Sciences–National Research Council that extrapolation from the levels of carcinogens (cancer-inducing substances) in the diets of animals to safe levels for man is "currently impossible," and the conclusion in a review by G. Burroughs Mider of the National Cancer Institute that "No one at this time can tell how much or how little of carcinogen would be required to produce cancer in any human being, or how long it would take the cancer to develop."

What the Secretary is advocating in effect is that at present he be given no administrative discretion for permitting the use of possible carcinogens as food additives under any conditions and at any concentrations.

Last week the Panel on Food Additives of the President's Science Advisory Committee took issue with this position. (Excerpts from the panel's report appear on page 1596. The panel points out that for many carcinogens there is evidence for the existence of a level of ingestion at which no carcinogenesis occurs during the lives of the animals tested and that dose-response curves have been worked out which allow prediction of the probability of cancer induction from a given dose. The panel also cites evidence to show that a dose-response relationship holds in certain human cancers.

On the basis of this and other evidence, the panel differs sharply from Secretary Flemming in recommending (i) that administrative discretion is essential now, rather than in the future, for deciding whether or not the use of certain possibly carcinogenic compounds as food additives should be prohibited; and (ii) that if such discretion does not now exist, the law should be modified. The panel proposes that an advisory board be appointed to assist the Secretary in evaluating the scientific evidence.

If the panel's recommendations are followed, it will be possible to consider each case on its merits—on the basis of risk relative to benefit—rather than to condemn all without the exercise of scientific judgment.—G.DuS.

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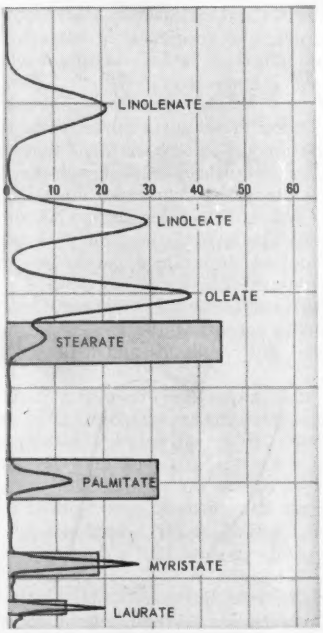

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27 May 1960, Volume 131, Number 3413 SCIENCE

Some Neglected Possibilities of Communication

For some kinds of messages the skin offers a valuable supplement to ears and eyes.

Frank A. Geldard

The great informers of events in the outside world seem obviously to be the visual and auditory channels. Depending somewhat on how the information is to be used, what chains of responses it will set off, we cast messages in visual or auditory form. Not exceptionally but more commonly than not, we code them auditorily:

1) If rapidly successive data are to be resolved. Audition is more useful than vision as a means of making temporal discriminations. Also, auditory reaction times are typically faster.

2) Where the recipient is preoccupied with other tasks or in a condition of reduced alertness and we wish to "break in" with unexpected messages or warnings.

3) Listening habits being what they are, where relatively brief, easy, highly meaningful materials are to be apprehended and remembered.

4) Where flexibility of message transmission is important. The voice spontaneously gives inflectional shadings and emphases.

5) Where, out of a larger mass of data, we wish to present information germane to an issue at hand—where we can, in advance of message transmission, be highly selective. The trouble with books, maps, and tables (all of them visual devices) is that you have to find what you are looking for.

6) Where visual reception is less available, whether by reason of environmental conditions that interfere with visibility, unfavorable orientation of the observer (a common visual difficulty), overloading of the visual channel, or outright sensory defect.

Visual coding seems to be indicated:

1) Where messages involve spatial orientation or guidance. Vision is the great spatial sense, just as audition is the great temporal one. Pictorial representation is often a boon.

2) Where fine discrimination is needed. Vernier visual acuity is the best the sense organs have to offer; we put our trust in needles on scales whenever we can arrange to do so in measurement operations.

3) Where complex, unfamiliar material is to be comprehended; the material is there, to be looked at again and again if need be.

4) Where reference data have to be immediately available or where simultaneous (or nearly simultaneous) relational comparisons have to be made.

5) Where a recipient of information has to make relatively prompt selection of data from larger stocks of information.

6) Where auditory reception is hampered by unfavorable environmental conditions, overloading of the auditory channel, actual auditory defect, or previously acquired attentional habits favoring vision.

These comparisons—or some like them—have been made many times and in a variety of ways, and I am indebted to my colleagues Henneman and Long for their review of this question a few years back, in which they placed just the right accent, it seems to me, on the contention that "the choice between the eyes and ears as sense channels for the presentation of information to the human operator rests upon the specific demands of various operational situations." In addition to having shown some of the relative virtues and defects of seeing and hearing, they were able to specify some message-processing situations in which two senses are better than one and some in which either sense will do (*1*).

The Skin as Informer

In all this debate about eyes and ears there has been scarcely a voice raised about other possibilities. Yet the human integument, housing several modalities, rivaling the ear as a temporal discriminator and greatly excelling the eye in this respect, sharing with the retina the property of somewhat orderly spatial extension, has many of the message-transmitting features commonly extolled in the eye and the ear. Let us glance back at our list. The skin can make both temporal and spatial discriminations, albeit not superlatively good ones in either case. It is a good "break-in" sense; cutaneous sensations, especially if aroused in unusual patterns, are highly attention-demanding. It is possible, therefore, that the simplest and most straightforward of all messages—emergency

The author is professor of psychology and chairman of the department, University of Virginia, Charlottesville. This article is adapted from his vice-presidential address to Section I of the AAAS, delivered 29 Dec. 1959 during the Chicago meeting. Portions of the article will appear in the forthcoming volume *Sensory Communication*, to be published by John Wiley and Sons, New York.

warnings and alerts—should be delivered cutaneously. Because of the relatively large areas available on the body surface, there are a great many sites of potential stimulation, provided only that the transduction problem be suitably engineered. Moreover, these vast expanses are practically unused, except for regulation of the water and heat economies of the organism. If we add the clear superiority of touch (when vision and hearing are lacking or impaired) to the remaining modalities, the chemical senses, smell and taste, we have a formidable set of properties to utilize in cutaneous message processing—a list that ought to challenge us to find ways to capitalize on it.

Use of Existing Devices

Now, two radically opposed approaches may be made in assessing the possibilities of cutaneous communication. If one is interested in trying to utilize, in novel ways, the world's current collection of hardware, the "things" our culture has surrounded us with as elements in conventional communication systems, one asks, for example, what the skin's capacity is for feeling the disturbances present in a telephone receiver or other electromechanical transducer and interpreting such movements. This is, in fact, what was asked years ago by those who became interested in "hearing through the skin." Their approach was reasonable, given as a starting point the considerations that the skin is quite capable of apprehending mechanical vibrations and that the world contains vast quantities of hardware capable of transducing speech and music into mechanical vibrations of an intensity that can be felt by the skin.

The argument was an evolutionary one: the eardrum, which does so well at picking up and transmitting the fine dance of the air molecules present in speech, is a descendant of a cruder but not dissimilar tissue also capable of behaving with some efficiency in acoustic systems. Why not simply train the skin to do substantially what the tympanic membrane does? There were many patient experiments, and enough came out of them to stimulate persistent effort. Human speech, suitably amplified, was applied to the fingers. After a sequence of 28 half-hour training periods, in one experiment (*2*) the feeler could learn to judge, with about 75-percent accuracy, which one of ten short sentences had been delivered to the skin. In another (*3*), after some 30 hours of practice, single words, presented without context, could be recognized about half the time. Even these poor levels of performance were not maintained if the talker changed his rate of presentation or if another person sat in for him. The efforts at getting the skin to master a language not natural to it eventually petered out; the approach of adapting existing hardware had, for all practical purposes, failed.

Building Blocks for Coding

If one attack is to force a receptor system to perform in an unnatural way by trying to adjust it to the world's existing communication devices, the other involves asking how the world's properties and materials might be utilized to get the most out of the senses.

What discriminations are possible for the skin? What is the stuff out of which a cutaneous language has to be built if it is to be optimally utilizable by the skin? Having ascertained what sensory dimensions there are, one is in a position to catalog the possible discriminations, relative and absolute, that might be made along such continua. Such a procedure should yield building blocks, collocations of stimulus properties, for coding. One would, indeed, be in possession of the stuff out of which all possible cutaneous communication systems could be constructed, provided only that the dimensional analysis was exhaustive and systematic. Then, what stimulus arrays were selected for coding and use would depend mainly on what had to be communicated—whether the "message" was a warning, directional or rate information, a more sophisticated and elaborate formal "language," or what not.

Dimensions of Mechanical Vibration

If one begins with repetitive mechanical impacts, vibration, there are available but a few stimulus dimensions of the first order. They are easily listed: locus, intensity, duration, and frequency. Mechanical motion is not the only possibility, to be sure—the skin responds to thermal, chemical, and electrical stimuli as well—but vibration is the most promising one if continuous signaling is contemplated. There are also some derived dimensions, and we shall come to them later. What of the first-order ones? This is not the place to review in detail all the psychophysical data. They are the joint products of a succession of workers in the University of Virginia laboratory, and most of them have been published (*4*).

Locus

Locus has never been systematically investigated, though a good deal is known about it through the studies of Spector (*5*) and Howell (*6*). The question of how many places on the skin can be utilized is not settled by extrapolation of the results of two-point esthesiometer measurements. Unlike static pressure, mechanical vibration applied to the skin does not stay "within bounds" unless special steps are taken to prevent its spread, though Békésy, with characteristic ingenuity, has devised a coaxial vibrator that will take the special steps (*7*). This means that, under ordinary conditions of stimulation, the two-point limen for vibration is many times greater than the static one for a given region. Howell, working in our laboratory, found that seven vibrators could be spaced on the ventral rib cage with 100-percent identifiability of locus, under his conditions. This is perhaps the limit for a practical cutaneous communication system. The chest accommodates five conveniently, and it is tempting—until one finds that it won't work—to consider the combinations of vibrators (31 signals for five contactors) that might be coded. The difficulty is that two or more simultaneously acting vibrators feel no different from one, once the static pressure of each has adapted out and provided the vibratory pattern is set up in all of them with the same onset. A split-second temporal differential is all that is needed to restore two local impressions, but this leads to the further complication that such a manipulation also provides the essential conditions for synthetic movement, tactual "phi." This, in turn, could be coded, of course, and we shall encounter it again later as belonging in the family of "derived" phenomena.

The failure to explore the entire body for locus as a codable cue is not the result of neglect, nor yet of lack of interest in the outcome. In this electronic age so many things have to await

technological advance. We simply have not had a transducer with the right properties to make the experiment feasible. When Howell had an array of eight vibrators on his subject's chest he was literally trapped in a forest of concrete-rooted supports, flexible goosenecks, and long, flat springs necessary, with the vibrators then in use, to insure independence of vibratory generation and preservation of uniform static background pressure. It is, therefore, a considerable satisfaction to report a technological "breakthrough" in the summer of 1959, whereby my colleague R. C. Bice succeeded in modifying radically a transducer of the hearing-aid variety to provide strong, low-frequency vibrations which are not readily damped by the skin. He also found an ingenious way of utilizing fabric fasteners to couple the vibrator firmly to any chosen site of stimulation. The instruments are sufficiently small and light, and their electrical properties are such as to yield high powers without undue heating. For the first time the systematic exploration of the dimension of locus seems to be in sight.

Why is it so important that it be explored? There are several reasons, but the chief one has to do with the bearing the result may have on communication theory. It is not inconceivable that nothing other than variation in absolute cutaneous locus, suitably coded, is necessary to provide as complex a communication system as may be needed for many purposes. Thus far, in exploiting locality as a dimension, we have confined all stimuli to the rib cage. This has not been an entirely arbitrary matter. The ventral thorax is a relatively traffic-free area of somewhat uniform sensitivity in the males of college age who served as subjects in our experiments. We also had in mind the possibility that applications of any cutaneous communication system we devised might be to vehicular situations in which all other major areas of the body surface would be ruled out as otherwise occupied, either by reason of their motility or their favorable relation to the body's center of gravity. Cosmetic considerations could not be entirely ignored, either.

However, these are accidental restrictions that need not be permanent, especially if we are getting at principles. It seems probable that the integument has a sufficient range of local "tags"—call them, with Lotze, "local signs," but don't trouble yourself, at the moment, with the perplexity they generated for a century—to yield a very considerable set of differentiable and absolutely recognizable signals which might be coded to provide a satisfactorily complete language. We have a hunch that the "magical number seven" may not be controlling, because the body schema calls for a fair number of named and familiar parts. The skin surface is "multidimensional," in Miller's meaning of the term (*8*), and channel capacity should increase accordingly. If this turns out to be the case then the problem may be that of ascertaining whether rapid attentional leaps may be made from one bodily region to another—from the forehead to the left calf to the right shoulder-blade, say—without benefit of psychoneurosis in any form. Well, there is not too much point in further speculation along these lines. The laboratory will provide the only acceptable answer.

Intensity

What of intensity? There have to be some limits. Each part of the integument has its own absolute threshold, and each part has its susceptibility to discomfort and to damage by the trip-hammer action of powerful vibrators. In the chest region a useful range of stimulus amplitudes is that limited by the values 50 and 400 microns; the former value is safely above the 100-percent absolute threshold, the latter falls well below the threshold of discomfort. Between these limits the average observer, under laboratory conditions and with the use of a careful psychophysical procedure, can detect about 15 steps of intensity. On an absolute recognition basis, unless one were to select subjects for the purpose or train them, it would be unsafe to include more than three steps, widely spaced over this range. Intensity is, in fact, the least exploitable of all the first-order dimensions. An analysis of errors in a communication system which coded locus, intensity, and duration shows nearly all the mistakes to have been made along the intensity dimension (*6*). There appear to be two chief reasons for this: (i) a fixed amplitude applied to different loci varies considerably in its "feel," perhaps owing to accidents of local innervation, perhaps to reinforcing or damping variations in underlying tissue; (ii) it is not easy, in view of breathing motions and disturbances coming from circulatory events, to maintain a strictly invariant relation between a mechanical vibrator and the skin surface on which it rests.

Duration

Duration of a continuous vibratory "package" is judged with some precision over the entire useful range. The range, of course, has to be selected on the basis of extraneous considerations. In our experiments we have chosen not to deal with any durations of less than 0.1 second, on the ground that a "buzz" much shorter than this is likely to be mistaken for a "nudge" or a "poke." At the other end of the scale we have set 2.0 seconds as a limit beyond which we are unlikely to wish to code signals; a communication system employing units lasting more than 2 seconds is certainly a ponderous one. Between 0.1 second and 2.0 seconds, then, there is a durational continuum within which the average observer can make about 25 distinctions, the steps being of the order of 0.05 second at the low end and 0.15 second at the high end of the range. This is again the relatively precise Δt of the psychophysical experiment. Absolute identifications with 100-percent accuracy yield four or five considerably more widely dispersed levels, and if there is to be neither selection of subjects nor training of them, it is safer to use only three levels.

Frequency

It is clear from all this that we possess three sets of building blocks of cutaneous communication systems—a limited number of absolutely discriminable steps of locus, intensity, and duration. There is, of course, a fourth primary dimension. This is frequency. The story of frequency discrimination in the vibratory realm is not a simple one. There is a history, and also there are some interesting outcomes of recent experiments. We may summarize the history by saying that failure to control for differences in subjective intensity, when frequencies were being compared, and for contaminating transients at the "on" and "off" points of the stimulus envelope has invalidated all measures obtained prior to those recently obtained

by Genevieve Goff in our laboratory (*9*). She overcame these defects by first assembling a band of equal-loudness stimuli, which differed in frequency, then measuring Δf systematically within that band throughout the obtainable frequency range. Her basic results show that, at very low frequencies, below 70 cycles, say, vibratory "rate" judgments are quite good, but it is equally clear that discriminability fades rapidly as the frequency scale is ascended. In the region that is best for speech sounds the skin does very badly indeed, and this finally explains why the "hearing through the skin" programs, alluded to earlier, yielded such disappointing results.

There is one additional difficulty where vibratory frequency is concerned; were it not for this it might conceivably be possible to transpose audible frequencies downward into the tactile range. The difficulty is this: The correspondence between vibratory frequency and perceived "pitch" is a tenuous and uncertain one. Vibratory pitch proves to be a joint function of both frequency and amplitude. To be sure, this is also true, for much of the audible range at least, in hearing as well, but intensity is only a very minor determinant of auditory pitch; the loudening and softening of pure tones can move pitch about only a little, and, if tones are as impure as they have to be to be musical, they apparently do not budge. Frequency is very nearly in absolute control. In the cutaneous sphere things are different. Increase the amplitude of a moderately loud 40-cycle sinusoidal vibration applied to the finger tip and it undergoes a marked downward shift of pitch. Decrease the amplitude and the pitch goes up perceptibly. Békésy has recorded shifts of the order of three octaves (*7*). It is obvious that frequency would have to be handled gingerly in a communication system, especially if intensity were simultaneously manipulated as a variable.

Language of Vibration

In our initial efforts to form a system of vibratory signals capable of being coded, only the three obviously useful dimensions of locus, intensity, and duration were employed. A simple alphabetic code was devised and applied successfully by Howell, so successfully that a subject who had invested a total of 30 hours in learning the alphabet of the "vibratese" language could, after a further training period of only 35 hours, receive sentences with 90-percent accuracy when these were transmitted at the rate of 38 five-letter words per minute.

This performance in no wise represents the optimal one. With the same rules as those of international Morse code with respect to interword and intraword spacing (0.1 and 0.05 second, respectively), the system requires only 0.79 second to transmit the "average" five-letter English word. This means that the ceiling transmission rate is 67 words per minute, a speed well over three times that of proficient Morse. To approach this rate, however, there would be required an extensive and somewhat elaborate engineering job to devise an automatic coder, perhaps of the tape variety, that would initiate signals faster than our present homemade machine, a manually operated typewriter that triggers "flip-flop" circuits (for time) and a bank of potentiometers (for intensity). The closing of the gap between 38 and 67 words per minute we leave to those interested in establishing world's records.

Meanwhile, what other building blocks are available? We have considered only the first-order dimensions of the vibratory stimulus. There are some derived dimensions, a few of which have already received some attention. It would be helpful to have additional codable cues, if only to be in a position to add redundant elements. Much has been written about purifying and simplifying languages by the reduction of redundancy. Where intelligibility is less than optimal there is much to be said for making the language more, rather than less, redundant, and the vibratese language would doubtless benefit by this kind of doctoring.

Intensity as a Function of Time

What are the candidates here? Intensity variations as a function of time present one set of possibilities. A signal may be imposed on the skin quite abruptly or more gradually, just as in music one may have variations in "attack," "hitting" a tone or "sliding into" it. Systematic manipulation of this variable has been carried out by Howell (*10*) for mechanical vibration, and by me for direct electrical stimulation of the skin with alternating currents. For mechanical stimulation, a growth of amplitude from zero to 480 microns—the largest that it was practicable to work with—and for rise times bracketed by the shortest transientless one for the system and the longest it would be reasonable to consider for signaling purposes (a growth requiring a full second to achieve), there prove to be six discriminable steps. As with all other similar functions, these come from the conventions of psychophysics. Absolute identifications are, of course, not spaced this closely. Indeed, if 100-percent recognizability of "attack rate" is demanded, over this range of onset slopes there are but two; the "magical number" proves to be seven minus five! There are presumably another two steps associated with offsets.

Wave-Form Variations

A second possibility, in the realm of derived dimensions, is wave form. This has not been investigated as yet, though it is clear that wave-form variations should be discriminable if the basic frequency is low enough. Still other moment-to-moment variations should be detectable. Perhaps it would be possible to introduce variations within signal envelopes other than those of onset and offset—a gradually increasing or decreasing frequency, say. This is a totally unexplored field.

Spatially Discrete Loci

Another patterning of stimuli involves space as well as time. As in vision, the successive stimulation of two separated receptive areas, provided the temporal relations are right, leads to perceived movement. Unlike vision, the critical time relation for tactual "phi" is the absolute interval between the beginnings of the two successive exposures, not the duration of the silent interval between them. Indeed, there need be no silent interval at all. They may overlap and still yield good movement if the onsets are properly spaced. Cutaneous phi has not been surveyed with a view to coding it and incorporating it into a communication system so much as it has been studied with respect to its essential conditions as a phenomenon, but clearly it offers some possibilities (*11*).

It is doubtful that vibratory phi should be coded into any language of the type I have already described. Indeed, in any rapid succession of signals applied to spatially discrete loci the crucial conditions for synthetic move-

ment are already given. Movement has to be overlooked, not apprehended in this situation, of course. On the other hand, the phenomenon of cutaneous movement is an extraordinarily powerful one; it is highly attention-demanding. Place a ring of vibrators around the body (for example, three across the front and three across the back of the thorax), energize them successively with a 0.1-second temporal separation, and there is felt a vivid "swirling" motion, entirely novel in the experience of most people, because the observer seems to be at the center of it! This effect is a completely prepossessing one, and, accordingly, it is an ideal one for coding in a different fashion, as a warning signal to be infrequently used but capable of highly significant coding. It would do valiant service attached to a "panic button."

Role of Cutaneous Communication

This raises the important question of the ultimate place of the cutaneous channels in the total communication picture. Coding to letters and numerals is really a quite pedestrian way of getting meanings into tactile patterns. There are, to be sure, obvious ways of making such a system "fly" at a faster rate. One way would be to code the vibratory signals to phonemes. We have not attempted it because of the prodigious investment entailed in learning the phonemes themselves, but it ought to be tried. It is also possible that there may be developed an entirely novel cutaneous shorthand, one capitalizing on distinctively tactile properties. Serious study of basic cutaneous perceptual phenomena, an area dignified by the devotion of not more than a dozen first-rate minds in the whole of recorded history, might turn up such a linguistic development.

Possibilities for cutaneous communication are by no means confined to conventional language, of course. Other kinds of information may be imparted tactilely. Rates, amounts, directions—anything falling on unidimensional or bidimensional continua—could presumably be communicated to the skin by way of suitably patterned mechanical impacts or sequences of them. One of these possibilities has already been exploited in our experiments. Vibratory tracking of the compensatory-pursuit variety has been carried out by lining up three vibrators across the chest, letting them be successively energized to give the impression of continuous movement in one direction or the other (through utilization of phi), such that the "arrowhead" always "points to" the target, and with the vibratory sequences temporally spaced to indicate degrees of urgency in getting back "on target." The subjects manipulated a steering wheel and attempted to eliminate all cutaneous signals by promptly neutralizing all off-target indications.

Ten subjects performed in response to these tactile signals. Ten others were presented the visual analog, lights being substituted directly for the vibrators. Both groups learned rapidly, and the vibratory performance was in no wise inferior to the visual. Whereas the visual situation is not the optimal one for this sense, of course—the target was traveling only at the rate of 3.5 degrees per second, and the eye can handle speeds many times as great—the tracking task imposed on the subjects was one that would keep all but the speediest vehicles comfortably on course, and the skin was handling the assignment fully as well as the eye.

Subsequently, this experiment was simplified. Synthetic movement was taken out of the display, the three vibrators were reduced to two, and even the "urgency" feature was eliminated. Now there occurred only a simple "nudge," a brief burst of 60-cycle vibration, to indicate direction off the target to the right or left. Performance showed no significant deterioration with this removal of redundancy in the signal. Only a meager display is needed to give directional information of a kind that is adequate for fairly complex performance.

Currently, there is being tested a bidimensional vibratory display designed to signal both "right-left" and "up-down" deviations from the target, such as occur in following a glide path or keeping a missile on course, and there is every indication that the system will do what is expected of it. The value for situations in which vision and hearing are pre-empted, for one reason or another, is obvious.

Electrical Stimulation

Another whole domain of possibilities opens up when we consider that only one form of energy, the mechanical, has thus far entered our calculations. Whereas not much is to be hoped for from the chemical and thermal forms of stimuli—they are both too ponderous in their operation to be of much use in communication; at best they could only provide the analogs of smoke signals—there is the whole important realm of electrical stimulation. The skin responds with lively patterns to both direct and alternating current. Indeed, the heart of the problem is that the patterns are, in general, somewhat too lively for comfort. We have devoted several years of intensive effort to finding the conditions of electrical stimulation that will yield codable vibratory patterns unaccompanied by pain and that can be reproduced on demand. The problem has turned out to be a slippery one. Electricity is the great "nonadequate" stimulus; it triggers everything, as physiologists well know. However, the important stimulus parameters are few in number and my colleague John F. Hahn has been able to isolate the really significant one in skin stimulation (*12*). Where square waves are employed and are systematically varied in frequency and duration, thus obviating any influence of the change in rate of current increase such as occurs with alternating current of variable frequency, it turns out that absolute threshold is related not at all to frequency but only to duration. This fundamental discovery permits us to narrow our search for the basic medium of reception in electrical sensitivity of the skin. The great stumbling block thus far is the omnipresent pain. While, under some reproducible conditions, pain tends to adapt out in continuous signaling, leaving behind a not too unpleasant tingle, it is doubtless asking too much, in practical communication situations, to expect anyone to tolerate from a transducer even transient discomfort.

Conclusion

I have indicated some of the kinds of things it would be important to know for further investigation of the cutaneous communication problem. There are others, many others. Indeed, almost any certain fact about somesthetic functioning is likely to prove valuable here. When one is working so close to the foundations of an edifice there is high probability that anything accomplished will turn out to be important for the superstructure ultimately to be erected. Though we address ourselves to the practical problem of getting messages transmitted over the cutaneous channel, we find ourselves asking about very

basic matters—about the perception of time and tactual space, about intensity discrimination, and about topographic variations in sensitivity. There is not the slightest doubt that a host of other observable cutaneous phenomena—adaptation, masking, reaction latencies, spatial interactions, temporal summations, "loudness" and "pitch" functions, recruitment effects, and so on—are more than peripherally related to the central problem. We have not yet really begun to look carefully into the communication possibilities offered by the human integument or even into the bare facts that provide the possibilities (*13*).

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The Mössbauer Radiation

Low-energy gamma rays provide the most precisely defined electromagnetic frequency yet discovered.

Winston E. Kock

One of the latest discoveries in physics which is now intriguing scientists in many fields remained relatively unknown for a year after its publication. Early in 1958 Rudolph L. Mössbauer published in the *Zeitschrift für Physik* (*1*) his first report concerning an emission and absorption process for low-energy gamma rays. Between that time and September 1959 there was no published evidence of any related work going on at other laboratories, yet today there is extensive activity at many institutions, including Harvard, Los Alamos, Illinois, and the Argonne Laboratory in America, and Harwell, Birmingham, Cambridge, and Manchester in England.

What is it about this new effect that suddenly has brought it such attention from the scientific community? Most spectacular is the revelation that the gamma-ray radiation involved has a frequency which is more stable by many orders of magnitude than the best atomic clocks available today. Because the electromagnetic waves involved have frequencies of the order of 10^{19} cycles per second, ordinary radio techniques for observing their amazing frequency stability are not usable. For his detector, Mössbauer employed an absorber which was similar to his radiator in that its absorption effect exists over the extremely small frequency range of the radiator.

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Experimental Techniques

Figure 1 shows how the narrowness of the frequency (or line width) of the radiator and absorber are measured. When the radiator is stationary relative to the absorber, the frequency of the radiated gamma ray and that of the absorber are identical and the counter reads a relatively low value. If, now, the radiator is set in motion relative to the absorber, a Doppler shift is imparted to the radiated electromagnetic wave and the two frequencies differ. The "stop band" of the absorber "filter" is no longer effective at the Doppler shifted frequency, and the counter reads a higher value than before.

From the velocity of the radiator as measured experimentally, the amount of Doppler frequency shift is known, and the frequency characteristics of the source and absorber can be ascertained.

Figure 2 shows a plot of the measured line width of the gamma ray of the isotope of iron-57, as measured by R. V. Pound and G. A. Rebka, Jr., of Harvard University (*2*). As shown in the figures, the half-width point corresponds to a source velocity of 0.017 cm/sec. When one considers that the velocity of light is 3×10^{10} cm/sec, the remarkable frequency stability of the gamma ray is evident. A velocity of one million millionth that of light has shifted the radiating frequency an appreciable amount from the absorber "filter" band. The center frequency of the line is 10^{12} times the line width; if a regulation capability of one thousandth of the line width (the capability normally achieved in present atomic clocks) is assumed, "the 'least count' in the Pound and Rebka experiment is about 3 parts in 10^{16}" (*3*).

Applications

To what use has this remarkable discovery been put? One of the applications contemplated earlier for precise atomic clocks was that of checking, from satellites, the gravitational red shift predicted by relativity theory. Relativity maintains that two identical clocks would run at different rates if one were kept on earth and the other were removed to a point of lower gravitational potential (for example, by means of a satellite). This gravitational effect is quite small; thus it would cause a clock at 2000 miles above the earth to differ from an identical earth clock by one second in 500 years.

The discovery of the Mössbauer effect changed the picture dramatically. Pound and Rebka (*4*) first published the suggestion that Mössbauer's findings would eliminate the need for the great height difference demanded by the con-

templated experiments with atomic clocks, that instead heights available in the laboratory should be adequate.

The technique would be to place the source and the absorber at different heights, and the difference in gravitational field would shift the frequency of one device relative to the other. The experiment was performed by T. E. Cranshaw, J. P. Schiffer, and A. B. Whitehead at Harwell in England (*5*) and by Pound and Rebka at Harvard. One parameter that unexpectedly turned out to be of importance was temperature; an extremely small temperature difference between the source and the receiver can swamp the sought-for effect. The Harwell group published their findings (which suggested confirmation of the gravitational effect, with some appreciable uncertainty) before this temperature dependence was appreciated. Pound and Rebka, on the other hand, found wide fluctuations in their results, due in part to the above-mentioned temperature effects. These effects were then taken into account, and Pound and Rebka's confirmation of the gravitational effect, appearing a month and a half after Harwell findings, is therefore quite convincing. Their quoted uncertainty error is quite small.

Mechanism of the Sharp Line

One wonders how such a narrow line of radiation can occur and why it has not been observed before. The gamma rays under consideration are emitted by nuclei, and normally the nucleus would experience a recoil upon emission of the gamma ray, thereby causing the frequency of the gamma ray to be shifted by various amounts.

Mössbauer considered the possibility that a nucleus held by the strong binding forces in a crystal lattice might cause the entire crystal lattice to absorb the recoil, and that this sharing of the recoil among huge numbers of atoms would permit the observed line width to be limited only by the length of the wave train of the gamma-ray photon. A wave train of an iron-57 photon has roughly 10^{10} waves, its frequency being 3×10^{18} cycles per second and its half-life 10^{-7} seconds. From the uncertainty relation $\Delta\gamma\Delta t \approx 1$, one arrives at the half-line width of 1 part in 10^{12}. The crystal recoil effect is also present in the absorber; its nuclei are accordingly in exact resonance with the unshifted line from the source.

History

It is interesting to follow the history of the developments since Mössbauer's orginal discovery, as the more recent ones have a sort of Horatio Alger touch.

As mentioned above, Mössbauer's publications were the only ones in the field for about a year. Then there appeared, in the 1 September 1959 issue of *Physical Review Letters*, two notes, both received 3 August. One reported on work by a group at the Los Alamos Scientific Laboratory; it essentially indicated that Mössbauer's experiments and results had been confirmed through the use of Mössbauer's original choice of the iridium isotope 191. The other was communicated by a group at the Argonne National Laboratory, also describing a verification of Mössbauer's results and reporting on a similar effect observed with tantalum-182 as a gamma-ray source against a tungsten-182 absorber.

An important advance occurred with the publication, in the 1 November issue of the same journal, of Pound and Rebka's note (*4*) suggesting (i) that

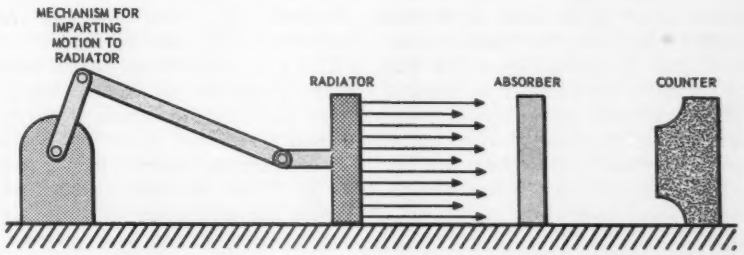

Fig. 1. When motion is imparted to the source of radiation, a Doppler shift occurs and the originally matched absorber is then less capable of absorbing the electromagnetic waves, as is indicated by the counter on the right. A loud-speaker drive is usually employed as the means of imparting vibration.

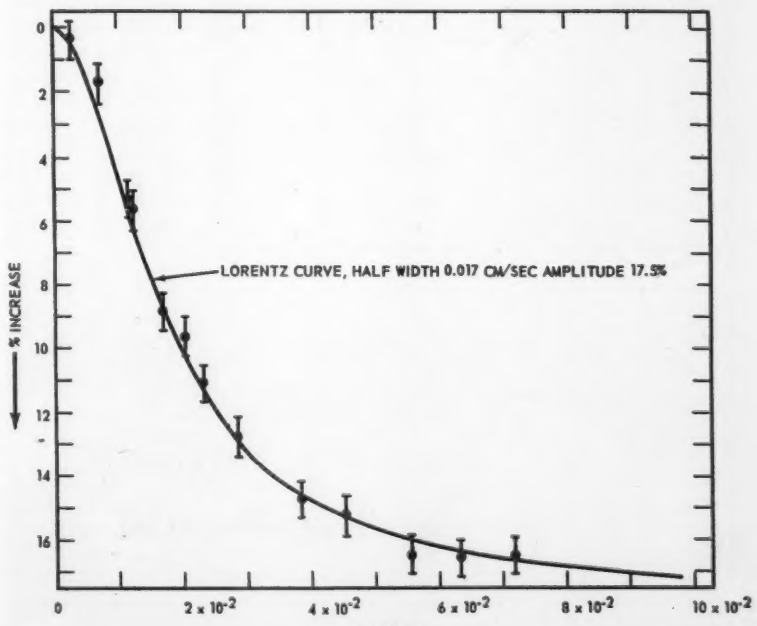

Fig. 2. The line width, expressed in megacycles per second, of the iron-57 radiation (3×10^{12} Mcy/sec), is obtained from calculations of the Doppler shift resulting from the relative velocity between source and absorber. [Pound and Rebka]

the Mössbauer effect be used to check the gravitational red shift and (ii) that iron-57, along with zinc-67, should furnish even sharper lines than Mössbauer's iridium-191. Shortly before this, one member of the Argonne group, J. P. Schiffer, went as a John Simon Guggenheim fellow to the British Atomic Energy Research Establishment at Harwell, and in the 15 December issue of *Physical Review Letters* two letters appeared, both received on 23 November, one from Schiffer and W. Marshall at Harwell and the other, a new note from Pound and Rebka. Both letters discussed experiments with iron-57, and Pound and Rebka produced actual curves showing the line width (Fig. 2) and the hyperfine structure. The 15 January issue also had two notes describing work on iron-57; one, by the University of Illinois group, included a hyperfine structure curve matching Pound and Rebka's, and the other, by the Argonne group, demonstrated polarization of the gamma radiation.

In the 15 February issue, Cranshaw, Shiffer, and Whitehead of Harwell published their conclusions on the gravitational red shift, with the rather large uncertainty of 0.96 ± 0.45 times the expected red shift. Another Harwell group reported in the same issue their measurements of the red shift in an accelerated system. The race, if one could call it that, appeared to be over, with Harwell (and Schiffer) the uncontested winner, when, to everyone's consternation, the 15 March issue appeared carrying the letter by Pound and Rebka which pointed out the strong frequency dependence on temperature of the iron-57 rays, as determined by theory and experiment. This letter had been submitted before the Cranshaw letter appeared in print, so no comment was made on the Harwell results. The reader, however, could readily recognize the importance of this parameter, and the Harwell letter was thereby placed under a cloud. Did the gravitational effect really exist or did it not?

What is probably the final chapter was the publication of Pound and Rebka's gravitational results in the 1 April issue of *Physical Review Letters* (*6*). It removed all doubt concerning the existence and extent of the gravitational red shift, the results matching the theoretical expectations by a factor of 1.05 ± 0.10. Fortuitously, a letter from B. D. Josephson at Trinity College, Cambridge, in the same issue (referring to the Harwell letter and to Pound and Rebka's earlier suggestions) pointed out the definite necessity of taking into account the dependence of frequency on temperature in such experiments.

The Future

Apparently one important relativity question is now settled, and scientists will be searching for other experiments which can capitalize on this very precisely defined electromagnetic frequency. Surely there will soon be practical applications of this narrow line. Pound and Rebka pointed out that at 10 cycles per second, the 0.017 cm/sec velocity which was equivalent to a half-line width corresponds to a peak-to-peak amplitude of 0.0009 centimeters. Were the source to be vibrated at, say, 1 megacycle per second, a velocity of 0.017 centimeter per second would correspond to a peak-to-peak amplitude of 9×10^{-9} centimeter (less than twice the radius of the hydrogen atom). Velocity- and distance-measuring methods of the future may well be based on this interesting new discovery.

Whether the actual electromagnetic frequency itself can be used as a stable source of frequency for subharmonic scaling circuits or for comparison with quartz clock oscillators remains an open question. Suffice it to say that much thought will be given to finding ways of utilizing the remarkable stability of the Mössbauer radiation in this way.

Nuclear experiments in this field will also continue, and through the results of these experiments more will be learned about the properties of matter and the solid state (*7*). Unquestionably, the Mössbauer effect has provided the experimental physicist with a powerful tool for the exploration of many of the remaining secrets of atomic physics (*8*).

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Donald J. Hughes, Nuclear Physicist

Donald J. Hughes, who died on 12 April at the age of 45, was a scientist who had played a unique role in the development of the field of neutron physics. Not only have his own researches yielded results of first importance and opened up new avenues of endeavor toward a basic understanding of many aspects of nuclear physics, but as a central driving force Donald Hughes had been the main factor responsible for the collation and unification of most of the information related to the interactions of neutrons with matter. In his extensive contacts with practically all of the neutron scientists of the world he had been instrumental in stimulating a tremendous amount of vital new research; furthermore, he had been one of the main U.S. scientific ambassadors responsible for our fruitful international relationships in the field of neutron physics and nuclear science in general. A most significant aspect of Hughes' work has been the fact that many of his various researches in fundamental neutron physics have led to almost immediate practical uses and are of major significance to reactor technology. Hughes was an eminent and respected member of the scientific community. He showed a deep

interest in the broader implications of his science. He was one of the signers of the famous Franck report, through which it was hoped to prevent the use of the first atomic bomb, and in 1955 to 1956 he was chairman of the Federation of American Scientists. The following chronological account of Hughes' accomplishments, while not complete, will give some idea of his various and important contributions to "the broad field of atomic endeavor."

Born in Chicago in 1915, Donald J. Hughes studied at the University of Chicago and obtained his Ph.D. in physics from the same institution in 1940. His Ph.D. research was in the field of cosmic rays, and as a result he became a member of a cosmic ray expedition led by A. H. Compton to South America in 1941. He remained at Chicago as an instructor in the physics department until the U.S. Navy called him to direct a section on underwater ordnance research at the Naval Ordnance Laboratory in Washington in 1942. Until 1943 he remained at the Naval Ordnance Laboratory, working with mine and torpedo detectors, except for a period spent with the British ordnance at Edinburgh, Scotland.

Early in 1943 Hughes joined the Manhattan Project at the University of Chicago at the time the first pile was starting operation. He performed classified pile neutron research, spending one year (1944) at Hanford, Washington, at the time when the large chain-reacting piles for production of plutonium were put in operation.

In 1945 he returned to Chicago and became director of the Nuclear Physics Division of Argonne National Laboratory. Here Hughes and his collaborators developed a method for measuring fast neutron cross sections that became the basis of G. Gamow's theory of the origin of the elements and that was also applied to the design of fast neutron breeder reactors, such as the experimental breeder reactor now in operation at Arco, Idaho.

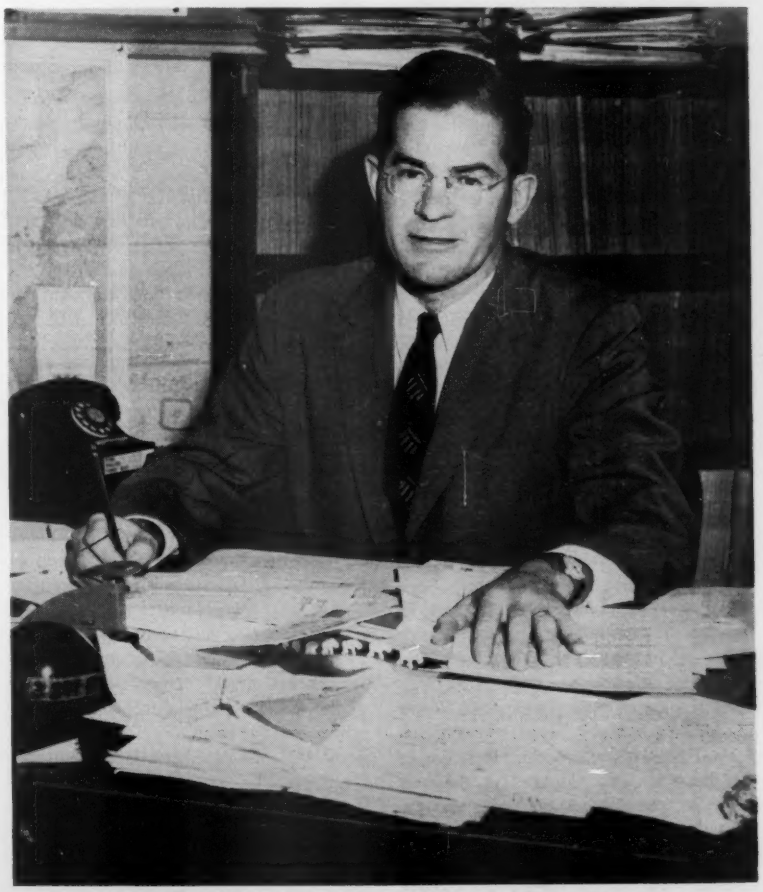
Hughes left Argonne in 1949 to become a senior physicist in charge of a pile neutron research group at Brookhaven National Laboratory. Here he and his group developed several new techniques which made possible extensive new studies in the field of neutron physics. One of these developments was the use of neutron "mirrors." This mirror reflection of neutrons was used by Hughes to make very significant studies of the character of the neutron-electron interaction, which had important bearing on modern meson theory. His group also developed the "fast chopper" device which greatly extended the energy range of accurate neutron cross section measurements. In addition to being effectively used by Hughes' group at Brookhaven, the fast chopper technique has now been adopted by most reactor neutron physics laboratories throughout the world.

His more recent work involved the utilization of "cold" neutrons to obtain information about the motions of atoms in crystals, which had hitherto been impossible to detect with available techniques.

At a very early stage in his neutron studies Hughes realized the importance of collating and unifying information on nuclear cross sections. His systematic collation of this type of data was started in Brookhaven around 1950. This collation of data, which has grown in magnitude with the years, has been the standard source of information for both basic research and many aspects of applied reactor technology. A published version of the cross section compilation, called *Neutron Cross Sections*, was distributed at the first atoms-for-peace conference in Geneva in August 1955. The second, completely revised, edition of this work was completed by 1958 and has received wide international distribution. In connection with his extensive interest in and knowledge of nuclear cross sections, Hughes served as a member and chairman of the Nuclear Cross Section Advisory Committee of the Atomic Energy Commission.

As one of the foremost experts in neutron physics, Hughes traveled widely to contact research groups in various parts of the world. Much of this travel was in connection with the neutron cross section compilation. Furthermore, he served as a lecturer for the U.S. Information Service during the period 1954 to 1956. In this capacity he lectured in Denmark, England, Finland, Germany, and the Netherlands.

He was one of the two American



Donald J. Hughes, at his desk at Brookhaven National Laboratory.

members appointed by the International Council of Scientific Unions to the Committee to Consider the Complications of Contamination of the Moon and Planets by Extraterrestrial Exploration (CETEX). Hughes participated in both the 1955 and the 1958 International Conferences on the Peaceful Uses of Atomic Energy as one of the representatives from the United States. Upon request of the secretary general of the conference, he presented papers reviewing the most recent worldwide nuclear data of technical importance.

In all of these international activities, Hughes established important contacts in many countries and was instrumental in developing a free flow of information between the United States and the rest of the international scientific community.

Hughes had been active as a teacher and a writer. He was a Fulbright professor at Oxford University in England from 1953 to 1954. He was the author of a number of books which have become standard works in the field of neutron physics. These include *Pile Neutron Research* (Addison-Wesley, 1953), *Neutron Optics* (Interscience, 1954), *Neutron Cross Sections* (Pergamon, 1957), and *On Nuclear Energy* (Harvard Univ. Press, 1957). An indication of the scientific value of these books is the fact that *Pile Neutron Research*, *Neutron Optics*, and *Neutron Cross Sections* have all been translated into Russian by the U.S.S.R. Hughes was also managing editor for a series of books entitled *Progress in Nuclear Energy*, which are published by Pergamon Press in London, and he was a highly valued member of the editorial board of *Science*. His latest book was *The Neutron Story*, which was intended for high school students and the interested general public. During his lifetime Hughes published some 115 papers in scientific journals concerning research with which he was associated.

HARRY PALEVSKY
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Science in the News

Oceanographic Research: Organizing Support for a Fragmented Program

A bill was reported by the Senate Commerce Committee last week authorizing an extensive 10-year program in support of oceanographic research. Hearings on a similar bill are being held in the House. As it happens, many of the agencies interested in oceanography have come out against the form of this particular legislation. Even its sponsors concede that it has no chance of passing this year, although some of the specific proposals may be passed in separate bills. Yet the bills have been the center of considerable interest, if only as symbols of the extent to which this very important but rather obscure branch of science has been brought to the attention of policy-makers in Washington. As a result, even without any formal legislation, spending in this area has been roughly doubled in the past 2 years, and further increases are expected.

When the organized effort to increase federal support for oceanography began about 3 years ago the science faced two especially important obstacles: it was popularly regarded as a field about as far removed from practical affairs as astronomy, and it faced a peculiar organizational problem in that the various elements of oceanographic research were fragmented among a dozen or so different government bureaus and agencies. As a result, although a growing number of people began to recognize that it was in the national interest to develop much enlarged support for the science, the fragments of the program scattered through the Navy, Interior, Commerce, and other departments and agencies tended to be little noticed in the over-all functions of the agencies and in their budget making.

A committee was formed by the National Academy of Sciences–National Research Council to report on the state of the science and to develop a national oceanographic program. This report was issued in mid-1958 and led directly to the formation of a special committee on oceanography in the House, and the formation of an interagency council on oceanography in the executive office of the President. (This council functions under the Federal Council on Science and Technology, which is headed by George Kistiakowsky, the President's science adviser.)

Much use was made of the perhaps illogical but nevertheless quite effective argument these days that the Russians are spending about three times as much on oceanographic research as we are. Press support was sought and gained, such as the fairly recent major article in *Fortune* and the cover story in *Time*. Even the techniques of Madison Avenue came into play, and oceanography began to be described as the exploration of "inner space," a term which may not be quite analogous to what is meant by outer space but which nevertheless sticks in the mind.

Possibilities of Research

In general, a fairly successful effort was made to acquaint Congress and the budget-makers with the sort of results that an expanded program could be expected to achieve.

There are, of course, a great many interesting problems in basic research, rare forms of life that have gone virtually unchanged for hundreds of thousands of years, crevices the size of the Grand Canyon, and mountains nearly as high as Everest protected from the erosion which tends to obscure some of the information that might be gleaned from these formations on land. There are "rivers" deep under the sea several thousand miles long and carrying currents several times greater than the Mississippi, and scientists are far from clear on the mechanism that causes them to exist.

But interesting as these questions

are, the growing federal support for the science stems from more practical motives. Paramount is the importance to the national interest of obtaining detailed maps of the submerged areas of the globe. The Polaris missile-firing atomic submarine could become our most important weapon system, and detailed maps would enable these submarines to calculate their positions within a few feet without ever venturing near the surface. The information would also be extremely useful for antisubmarine warfare. Beyond such direct military applications the time is seen ripe for making enormous strides in "farming" the sea, in controlling food fish, and, to a surprising extent, in controlling the weather.

It is pointed out, for example, that the difference in density between deep and surface water is a matter of the fifth decimal in relative density. This makes practical the "plowing" of the sea at a trivial expense of energy compared with that which is required to turn over the earth. It is suggested that releasing compressed air from tubes laid under certain areas of the sea could raise vast quantities of nutrient-laden deep water to the surface, with the result of producing a great increase in the yield of fisheries. The same technique has been suggested as a method for keeping certain ports, now ice-locked much of the year, open through the winter; compressed air would be used to raise currents of warm subsurface water to the surface.

Weather Control

It has been suggested that at certain critical points it may be possible to apply sufficient pressure to shift major ocean currents enough to alter quite substantially the prevailing climate in huge land areas. And it has been noticed that arid coastal areas receive increased rainfall when the sea is foamy. This is because droplets thrown into the air evaporate, leaving minute salt particles which are carried aloft where they serve as the nuclei of raindrops. It has been suggested that compressed air, again, might be used to achieve this effect artificially, producing substantial increases in rainfall along these now arid coasts.

Organizational Problems

It is the publicity that all these things have received from the NAS–NRC report and the other forces at work that have led to the increases in support for the science. But assuming, and opinions vary on this, of course, that oceanography has now achieved a proper degree of support in relation to other scientific programs, the question is raised whether this rather makeshift, basically political, method of rallying support for oceanography is really satisfactory and efficient. It is tempting, in situations like this, to seek some organizational cure-all, and advocates of a cabinet-level Department of Science sometimes point to an area like oceanography as an outstanding example of where such a department could function to establish priorities in various fields of science and to organize support in a more straightforward and less time-consuming method than had to be used in this case.

Indeed, several of the scientists who appeared before the Jackson committee this month, while opposing a Department of Science, suggested that in the case of areas like oceanography, which are so fragmented that there is no one who really feels responsible for the area as a whole, the National Science Foundation might be used to present a unified program to Congress and then distribute the appropriations to the operating agencies, as it now distributes research funds to nongovernmental agencies.

This would alleviate the sort of problem that was run into when the House subcommittee handling Commerce Department appropriations cut out the $300,000 of the over-all program assigned to the Weather Bureau. To this subcommittee the Weather Bureau is only a minor function of the Commerce Department, and when they began looking for things that could be cut it is not surprising that they questioned the necessity of the Commerce Department supplying the Weather Bureau with funds to do research in the ocean.

A considerable amount of effort, both in the executive and in Congress, has been going into such organizational improvements. In fact, there is a good deal of experience that suggests that more organization, by removing authority one degree further from operating responsibility, often succeeds only in further complicating the problems it was intended to cure. So the desire to seek organizational solutions is tempered by the recognition that there is a limit to the degree to which neat organization charts can really solve administrative problems.

Test Ban Talks: They Are Continuing Despite Summit Collapse

The technical side of the test ban negotiations continued through the collapse of the summit last week. Arrangements were being made to resume the political negotiations this week as the U.N. began the debate of the U-2 incident.

Officials here are pessimistic over the possibility of reaching agreement, for the principal unsettled issue is the question of inspection, and the events of last week will tend to make it more difficult to reach a compromise on this issue. On the one hand, the Russian contention that the West will use the proposed inspection as a cover for espionage has been strengthened; on the other hand, Khrushchev's exceedingly erratic behavior has led to new demands here that a really elaborate inspection system is needed to make sure that the Russians will not cheat.

British Prime Minister Harold Macmillan has told Parliament that he had gone to Paris with the hope that the remaining details for a test ban treaty could be pretty well worked out during the summit meetings. He said that even after the blow-up both Khrushchev and Eisenhower had assured him that their governments' policy of working toward a formal ban had not been changed, but that "I should not conceal from this House that this process may be somewhat less rapid than I had hoped." It was generally felt here and abroad that Macmillan's remark was a fine example of the British art of understatement.

There is a consensus of opinion that Macmillan is correct in his belief that basic policy on a test ban, as well as on other matters, has not been changed because of the blow-up. It was felt that this was indicated by Khrushchev's comparatively conciliatory speech in East Berlin, when he said that he had no intention of precipitating another Berlin crisis, that he hoped to settle the issue amicably at another summit conference "in 6 or 8 months." More specifically in regard to Geneva, it was noted that the Russian agreement to include nuclear as well as conventional explosions in the underground test research program, which the Russians regarded as a concession, came several days after the U-2 was downed. After our announcement of plans to resume nuclear testing as part of the detection program, a New York *Times* report

from Geneva suggested that our own representatives had interpreted this announcement as implying more than the Russian agreement in principle had actually conceded. Our representatives consequently expected a sharp Russian reaction. But the Russians did not make a fuss over the issue, and this mild reaction, when the Russians had an excellent opportunity to disrupt the meetings, came a week after the plane was down and several days after the story had broken into the open. From this and similar evidence, many observers incline to the belief that the Russians never intended any major alteration in their policies, but at Paris were reacting to what they felt was a sharp challenge to their national prestige contained in our public statements regarding the U-2. Indeed, James Reston reported that even as Khrushchev was going through the process of disrupting the conference his aides were assuring their Western opposite numbers that the Geneva conferences would continue.

American Reaction

On the American side we have already announced that the U-2 flights have been stopped and will not be resumed, and Eisenhower's somewhat enigmatic remark in Portugal that "perhaps here and there leaders make mistakes" was widely interpreted as an indication that despite the official American position, which puts all the blame on the Russians, the American leadership privately feels that we, too, were at fault.

Nevertheless, no matter how conciliatory the reaction of the Russians and ourselves, it is still felt that there is a serious question as to how much the Geneva negotiators will be able to accomplish until some months have passed and the tensions of the past weeks are relaxed. Even before the summit the President was under pressure to resume testing. Serious doubts had been raised regarding the degree of risk involved in the proposed treaty. These pressures and doubts will certainly be increased now. Joseph Alsop has reported that before leaving Paris Defense Secretary Thomas Gates and Chairman John McCone of the Atomic Energy Commission both urged the President to break off the Geneva talks. Edward Teller has made a strong statement asking for an immediate resumption of weapon testing in view of the collapse of the summit talks.

These men are far from alone in taking the position they do, and although the arguments they put forth have so far won only minority support in the political community, there are nevertheless serious arguments which cannot be lightly brushed aside. No one knows how much influence these views, strengthened by the summit breakup, will have. So far there has been no indication that will lead to an American withdrawal from the Geneva talks, but certainly no one expects a test ban treaty for a good many months.

There remains the *de facto* ban that has been in effect for 2 years. (Except for the two French tests, no one, so far as is known, has exploded a nuclear bomb since 1958.) But, it is pointed out, the real significance of the proposed treaty is not that it will stop ourselves and the Russians from further weapon development (We each already have the power to kill everyone on earth several times over.) but that it will be a step toward general disarmament and, more immediately, toward preventing the spread of atomic weapons to the at least half a dozen other powers, including Red China, which will be in a position to test nuclear weapons within a very few years.

Atoms for Peace Awards Presented

Four scientists who have made fundamental contributions to the development of nuclear reactors were presented with the $75,000 Atoms for Peace Awards for 1959 and 1960 on 18 May in a ceremony at the National Academy of Sciences. Leo Szilard, professor of biophysics at the University of Chicago, and Eugene P. Wigner, professor of theoretical physics at Princeton University, share the 1959 award, and Walter H. Zinn, vice president of the Combustion Engineering Corporation, and Alvin M. Weinberg, director of the Oak Ridge National Laboratory, share this year's award.

All four men are pioneer nuclear scientists who worked together at the Metallurgical Laboratory of the University of Chicago in 1942, when the first self-sustaining nuclear reaction was achieved at Stagg Field on 2 December. Szilard and Wigner composed the famous letter to Franklin D. Roosevelt from Albert Einstein that resulted in large-scale governmental support of nuclear investigations [see *Science* **131**, 1086 (15 Apr. 1960)].

The Atoms for Peace Award was established by the Ford Motor Company in 1955 as a memorial to Henry and Edsel Ford.

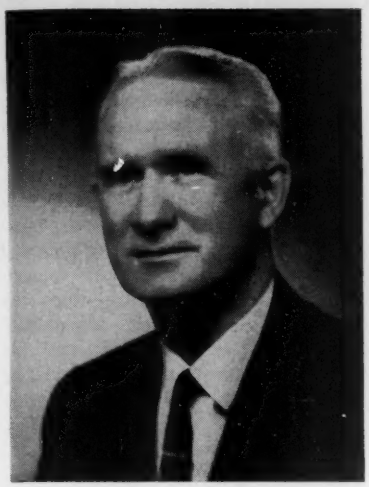
Winners Comment on Test Suspension

At a news conference after the presentation, the award winners were asked what they thought about current proposals for nuclear test suspension. Both Szilard and Wigner expressed a concern that the three-nation monitoring system under consideration at Geneva would only lead to friction and confusion.

Szilard doubted that the proposed system would stop nations that do not yet have atomic bombs from developing them. He commented: "Scientists cannot bring about disarmament, but they

Leo Szilard

Eugene P. Wigner



Walter H. Zinn

Alvin M. Weinberg

can help police disarmament." Then he suggested that atomic-weapon scientists of all countries be brought together to work on methods of detection. He proposed that they be offered a reward of $1 million for reporting any violation of a test ban.

Fourth Berkeley Symposium on Mathematical Statistics and Probability Announced

The Statistical Laboratory of the University of California, Berkeley, announces its fourth symposium, to be held over the 6-week period, 20 June–30 July. The Berkeley symposia, which began in 1945, are organized at 5-year intervals and are meant to present cross sections of contemporary research in probability and statistics and in various fields of application of these two disciplines. The proceedings of the first three symposia were published by the University of California Press. Reflecting the growth in the theory of statistics and of probability and also the unprecedented expansion of their applications, these proceedings increased in size from 505 pages for the first symposium to 1069 pages for the third. The proceedings of the fourth symposium are expected to be even more voluminous.

The program of the fourth symposium has been arranged with the active participation of an advisory committee composed of delegates of the American Mathematical Society and of the Institute of Mathematical Statistics. Financial support was obtained from the National Science Foundation, Office of Naval Research, Office of Ordnance Research, Air Force Office of Scientific Research, and National Institutes of Health.

The program lists 116 separate papers. The subject matter of these papers falls under four main headings: theory of probability, theory of statistics, applications to physical sciences, and applications to biology, including problems of health.

The emphasis is on theory. Papers on probability are mostly concerned with stochastic processes of various types. Briefly, these are mathematical models of chance phenomena developing in time or space, or in both, in which the occurrence of an event at one point affects the probabilities of occurrence of various possible events at other points. For example, John Doe, a sixth-grader in New York, and Michael Smith, a sixth-grader in San Francisco, are both exposed to the risk of contracting measles this summer; if John Doe gets measles in May, the chances that Michael Smith will get measles in June will be slightly increased. Thus, the mathematical model of epidemics is a stochastic process.

The main subject of papers on statistical theory is the determination of optimal rules of behavior, or of decision-making, under conditions of uncertainty.

The theoretical papers to be presented at the symposium are too specialized to be intelligible to the general public. In fact, some of the titles may appear bewildering. "Almost sure non-derivability everywhere of sample curves of Brownian motion" is one example. "Optimal stopping rules and semi-martingales" is another. However, abstruse as these titles may seem, the studies of the subjects concerned have a profound influence on a great number of domains of scientific research of general interest. These are reflected in papers dealing with the applications.

Applications to Biology and Health

The applications to biology and problems of health to be discussed at the symposium include applications in the study of carcinogenesis, population dynamics, epidemiology, mechanism of drug action, and cellular phenomena. In each of these phenomena there is unpredictability of single occurrences combined with certain regularities in frequencies. Whether John Doe or Michael Smith will actually be ill with measles this summer is unpredictable. On the other hand, the frequency of occurrence of cases of measles exhibits a regularity which is one of the subjects of probabilistic and statistical study of epidemics.

The common feature of probabilistic and statistical research in the various fields of application is that efforts are made to guess the structure of the chance mechanism of the phenomena studied. This structure is represented by a combination—occasionally a very complex combination—of several simple chance mechanisms, comparable to a toss of a coin.

If one takes under consideration only one or two manifestations of a biological phenomenon—such as, for example, the age-specific death rates from cancer—the problem of a hypothetical chance mechanism reproducing the observations may not be too difficult. Essentially, this particular problem reduces to the so-called problem of curve fitting. However, its solution need not be very interesting. The really interesting and important problem of carcinogenesis is the construction of a comprehensive chance mechanism, involving elements identifiable in biological studies. The consequences of this mechanism must agree with a great variety of different manifestations of the phenomenon.

With reference to carcinogenesis, to which a considerable number of papers will be devoted, these manifestations include not only the age-specific rates but also the dependence of these rates on doses and on the methods of administering various carcinogens, the

variability in size of tumors observed at different times, the speed of their growth, and so forth. The theories to be discussed range from one- and two-step mutation theories, to cumulative processes, to virus carcinogenesis. Since the development of cancer is essentially the process of growth of a population of cells of a particular kind, all theories of carcinogenesis tie in with population dynamics and with problems of epidemiology. Mathematically, all these problems are concerned with stochastic processes of a particular kind.

Applications to Physical Sciences

Physical-science applications of statistics and probability to be discussed at the symposium include certain occurrences in cloud chambers, stochastic theory of precipitation, and problems of astronomy. In the latter category, several papers originating in England deal with the chance mechanism of losses of comets. The mechanism contemplated is particularly interesting because it involves not only kinematical considerations, which are comparatively easy to deal with, but also dynamics. Other papers on astronomy deal with the realm of galaxies. Here, one of the problems treated consists in discriminating between two alternative hypotheses regarding the nature of systems of galaxies: double galaxies and clusters. According to one hypothesis these are stable dynamical systems. According to a more recent hypothesis, members of such systems fly apart, possibly as a result of a cataclysmic explosion.

Special Events Planned

Special events at the symposium will include a commemorative session for the recently deceased Russian probabilist A. Y. Khinchin, whose works exercised and still exercise a strong influence on research all over the world. The speakers at this session will be J. L. Doob and E. Montroll from this country and B. V. Gnedenko from the U.S.S.R.

Another special session is planned to honor Harold Hotelling, the Nestor of statisticians in the United States. A jubilee volume published by Hotelling's admirers will be presented to him.

In line with the rapidly spreading use of high-speed electronic computers in the course of statistical studies of natural phenomena, arrangements are being made by the International Business Machines Corporation for demonstrations of the effectiveness of two of its machines, the 701 and the 704, on the Berkeley campus of the University of California.

Symposium's International Character

The fourth Berkeley symposium will differ from its predecessors in its international character. The first symposium of 1945 was a purely American meeting. At the second symposium, 5 years later, there were eight contributions from abroad. At the third symposium, in 1955, this number grew to 12. Now the program lists 47 papers promised from abroad, 40 percent of the total. The geographical distribution is as follows: 11 papers from England; eight from the U.S.S.R.; four from Sweden; three each from Belgium, France, Hungary, and Poland; two each from Czechoslovakia, Denmark, and Japan; and one each from Australia, Canada, Germany, India, Israel, and Italy.

It is hoped that with this world-wide distribution of invited participants, the symposium will reflect adequately the current status of probability and statistics on this planet. Also, the interchange of ideas on common subjects of study, approached at different points of the globe and inevitably by different methods, holds excellent promise of speedier progress in research. Thus, unless the intricacies of the present political situation interfere, the organizers of the fourth symposium look forward to seeing useful and far-reaching results from this truly international effort at intellectual cooperation.

J. NEYMAN

Statistical Laboratory,
University of California, Berkeley

Nubian Archeological Expeditions

Froelich Rainey, director of the University of Pennsylvania Museum, has undertaken a special trip to the United Arab Republic and the Sudan to plan a joint archeological expedition with W. Kelly Simpson of the Peabody Museum at Yale University. The proposed expedition will be made under the auspices of UNESCO's project to preserve the archeological treasurers of Nubia which are threatened with inundation as a result of construction of the High Dam at Aswan.

Accompanying them is Mrs. H. Gates Lloyd, member of the U.S. National Commission for UNESCO and chairman of its special committee which explored the possibilities of U.S. support for the Nubian project. Rainey is a vice-chairman of the newly formed U.S. Committee for the Preservation of the Nubian Monuments. The party plans to visit Aswan and subsequently to ascend the Nile by boat to investigate archeological sites.

The Oriental Institute of the University of Chicago has also announced plans for a program of excavations and documentation in the area. A committee to administer a 5-year project has been formed under the directorship of Keith C. Steele, who is now in Egypt conferring with officials and inspecting sites.

Additive Report Released by Science Advisory Committee

The following excerpts (see page 1581) are the major recommendations from a recent report on the use of chemicals and drugs as food additives that was prepared by a special panel of experts convened by the President's Science Advisory Committee. Findings of the study were approved by the President's Special Assistant for Science and Technology, George B. Kistiakowsky.

. . . Under the Food Additives Amendment of the Federal Food, Drug, and Cosmetic Act, the Secretary of the Department of Health, Education, and Welfare may establish regulations prescribing, with respect to one or more proposed uses of the food additive involved, the conditions under which the additive can be used. The Act provides, however, that no such regulation shall be issued if a fair evaluation of the data before the Secretary fails to establish that the proposed use of the food additive, under the conditions of the use to be specified in the regulations, will be safe. Accordingly, the Food and Drug Administration has an area of administrative discretion in determining the safety of food additives under conditions of proposed use.

This area of administrative discretion has recently been greatly narrowed in those cases where a new food additive is a possible carcinogen. In 1958, Congress enacted the Food Additives Amendment of the Food, Drug, and Cosmetic Act. Section 409 (c) (3) . . . of the Amendment states that "no additive shall be deemed to be safe if it is found to induce cancer when ingested by man or animal, or if it is

found, after tests which are appropriate for the evaluation of the safety of food additives, to induce cancer in man or animal." The panel has focused attention on this proviso which, under the language of the Food Additives Amendment, is concerned chiefly with new substances. . . .

The panel subscribes to the intent of the Congress in approving this Section of the Food Additives Amendment to protect the public from increasing cancer risks through the diet. However, there are certain difficulties in its practical application—difficulties which give rise to many uncertainties both on the part of the public and those whose responsibility it is to administer the law.

Scientific Uses

Several scientific problems raised by Section 409 (c) (3) have been examined in detail by the panel. These are: *Problem of Recognition of a Carcinogenic Food Additive.* . . . It is to be noted that a finding of cancer induction in man or animal must be made as a prerequisite to banning of the additive in question. This recognizes the fact that the present state of scientific knowledge does not permit an *a priori* assumption of the carcinogenicity of a chemical. Since tests on animals or observations on man must be carried out to determine the capacity of an additive to induce cancer, it is pertinent to examine the procedures in current usage to recognize a carcinogen for man and/or animals.

Recognition in Man. The recognition of chemically induced cancer in man is based on circumstantial evidence. Although cancer morbidity may be in part related to environmental carcinogens, these have not been specifically identified in most instances because of the numerous, varied, and often unrecognized environmental factors to which man has been exposed. When, however, certain limited populations have had, through their specialized occupation, a concentrated exposure to specific environmental factors, it has been possible in a number of instances to obtain evidence indicative of a causal relationship between the specific environmental factor and the induction of cancer. Examples of this include urinary bladder cancer among workers in the dye industry exposed to 2-naphthylamine, lung cancer among chromate industry employees, and skin cancer among those engaged in the paraffin pressing operation in oil refineries.

The recognition of the relationship between an environmental factor and an increased frequency of a particular type of cancer in these examples rested on a marked difference between exposure of the individuals involved and the general population. Since, by contrast, exposure to food additives is general throughout the population, it is unlikely that carcinogenic properties would be recognized from examination of data obtained on man. From a practical standpoint, therefore, the indication of possible carcinogenicity to man of chemical additives must come from observations on laboratory animals or on persons exposed to unusual amounts of these chemicals during their manufacture or use, or in the treatment of disease.

Definition of Induced Cancer in Animals. The recommended procedure for testing the possible carcinogenicity of a chemical additive calls for its incorporation into the diet of several animal species, at several dosage levels, and for the duration of the animal's life span where feasible. Like all biological assay methods, this procedure has more inherent variables than do procedures involving physical and chemical methods. Further, the recognition of a carcinogen by the bioassay technique presents greater difficulties of interpretation than are usually encountered in assaying the effects of other pharmacologically active substances. These difficulties of interpretation are related to the identification of the tumor as a cancer, and to the way in which the experiment is designed. . . .

Problem of the Relation of Dose to Cancer Production in Man. Section 409 (c) (3) of the Food Additives Amendment of the Food, Drug, and Cosmetic Act prohibits the approval of a food additive regardless of the amount that is found to be required to increase the incidence of cancer in test animals. A literal interpretation of the Section must lead to the prohibition of such a substance even though present in trace amounts. Since new substances will be evaluated by animal tests, in practice the prohibition is based on the assumption that a substance which increases the incidence of cancer when included in the diet of animals at any dose level may increase the incidence of cancer when included in the diet of man even when present in amounts detectable only by the most sensitive analytical techniques. For a number of carcinogens that have been studied, however, there is evidence for the existence of a level of ingestion at which no carcinogenesis occurs during the life of the animals when tested in limited numbers. Also, dose-response curves for certain potent carcinogens in animals have been worked out from which can be reliably predicted the probability of an individual, in a given sized population, developing a tumor from a given dose of carcinogen. Such curves lead to the conclusion that dietary levels of carcinogenic agents exist at which the probability of cancer induction in animals is near zero.

The conclusion derived from animal studies has relevance to certain common components of the diet of man. In foodstuffs, as they occur in nature, one finds traces of chemicals which in larger amounts are generally accepted as carcinogenic, such as certain inorganic arsenic compounds, radium, and selenium. It can be shown by methods of analysis now available that ordinary table salt derived from rock salt contains trace amounts of radium and that foodstuffs containing iron salts are contaminated by minute quantities of arsenic. Although it cannot be stated absolutely that these traces of carcinogenic materials have never induced cancer in any human, the available evidence has not directed suspicion to these trace amounts as significant to the over-all cancer morbidity.

There is additional evidence which indicates that a dose-response relation for carcinogens exist in man. Thus, the bladder cancer incidence rate in those exposed to 2-naphthylamine . . . was highest among those most intensely exposed among several groups of workers in the dye industry. Another example of the existence of the relation of dose of a carcinogen and duration of exposure to cancer production is creosote, to which there is widespread exposure of workers in several trades. Although it has been demonstrated that creosote can produce skin cancers in mice and men, the frequency with which this has been observed in man is very low and only in those persons exposed to high amounts of the material over prolonged time periods. Finally, there is some indication in the literature that the frequency of cancer induction in man might be decreased by reduction of the amount of exposure to a particular carcinogen. Examples of this are the absence of reports of skin cancer in paraffin pressing operators in oil refineries following the introduction of

hygienic practices, and the reduction of nose cancer in nickel industry workers following the introduction of dust control measures. In these examples, it can reasonably be assumed that there has been a reduction in the exposure to the carcinogen rather than a complete removal of the cancer producing substance.

From the experience obtained in animal experiments and study of humans who have been exposed to carcinogens in the course of their work such as cited above, the panel believes that the probability of cancer induction from a particular carcinogen in minute doses may be eventually assessed by weighing scientific evidence as it becomes available.

Conclusions and Recommendations

The rapidly increasing number of new chemicals potentially useful in agriculture and food production demands vigilant and careful scrutiny of the compounds offered in order to safeguard the consumer from those that may present carcinogenic and other toxic hazards.

In applying the provisions of Section 409 (c) (3) the enforcing agency must employ the "rule of reason." . . .

The definition of a carcinogen implicit in the language of Section 409 (c) (3) requires discretion in its interpretation because so many variables enter into a judgment as to whether a particular substance is or is not carcinogenic.

It is to be emphasized that the present difficulty in establishing whether there are permissible levels for certain possibly carcinogenic food additives is accentuated by the limited relevant scientific information available. From the experience obtained in animal experiments and study of humans who have been exposed to carcinogens in the course of their work such as cited above, the panel believes that the probability of cancer induction from a particular carcinogen in minute doses may be eventually assessed by weighing scientific evidence as it becomes available.

The special emphasis placed by the Congress on the protection of the public from the dangers resulting from the addition of possible carcinogens to food calls for prudent administration of Section 409 (c) (3) of the Food Additives Amendment of the Food, Drug, and Cosmetic Act. Since an area of administrative discretion based on the rule of reason is unavoidable if the clause is to be workable, it is essential that this discretion be based on the most informed and expert scientific advice available. Until the causes of carcinogenesis are better understood, each situation must be judged in the light of all applicable evidence. In this way the protection of public health can best be assured.

Accordingly, the following recommendations are made:

. . . That the Secretary of Health, Education, and Welfare appoint a board advisory to him to assist in the evaluation of scientific evidence on the basis of which decisions have to be made prohibiting or permitting the use of certain possibly carcinogenic compounds.

The advisory board should be composed of scientists from the National Cancer Institute, the Food and Drug Administration, the U.S. Department of Agriculture, and the scientists outside the Government from a panel nominated by the National Academy of Sciences.

It would be the function of the board to weigh evidence and to make recommendations to the Secretary of the Department of Health, Education, and Welfare on the basis of available scientific data, both on applications for approval of new food additives and in all cases where the withdrawal of a prior approval or sanction is under consideration. . . .

If existing legislation does not permit the Secretary of Health, Education, and Welfare to exercise discretion consistent with the recommendations of this report, it is recommended that appropriate modifications in the law be sought. . . .

Members of the Panel

Detlev W. Bronk, chairman, president, Rockefeller Institute and president, National Academy of Sciences.

Robert F. Loeb, vice chairman, Bard Professor of Medicine, Columbia University—on leave.

Edwin B. Astwood, professor of medicine, Tufts University School of Medicine, New England Center Hospital.

Alfred Gellhorn, director of the Institute of Cancer Research, and professor of medicine, Columbia University.

J. George Harrar, vice president, Rockefeller Foundation.

Harold C. Hodge, professor of pharmacology and toxicology, University of Rochester.

James G. Horsfall, director, Connecticut Agricultural Experiment Station.

C. N. Hugh Long, Sterling professor of physiology, Yale University.

C. Chester Stock, scientific director, Sloan-Kettering Institute for Cancer Research.

Biological Sciences Curriculum Study To Test New Courses

The Biological Sciences Curriculum Study has announced the establishment of centers for testing proposed new courses to improve the quality of biology taught in American high schools. Approximately 15,000 high-school pupils and 100 teachers in 28 school systems will cooperate throughout the 1960–61 school year in testing both the scientific content and the design of instructional materials.

At each center, seven high-school biology teachers and a university biologist, serving an consultant, will take part, according to Arnold B. Grobman, director of the Curriculum Study. The nationwide evaluation program will begin in September.

The Biological Sciences Curriculum Study is an educational program of the American Institute of Biological Sciences. Funds for the study have been provided by the National Science Foundation in grants totaling $738,000.

The Curriculum Study has its headquarters at the University of Colorado. It is an autonomous activity, directed by a steering committee of 26 outstanding biologists and educators, of which H. Bentley Glass, professor of biology at Johns Hopkins University is chairman.

Elementary School TV Biology

The television series "21-inch Classroom," in cooperation with the Children's Museum of Boston and the Massachusetts Audubon Society, has been presenting a series of 30 half-hour television programs dealing with the principles of biology. Teacher for the series is professor William H. Weston of Harvard University, and the producer is Charles Walcott. The programs have included presentation at the fifth-grade level of some of the major ideas of biology. This has involved the extensive use of live animals and plants, original film, and special art work.

During the current year the series is being used in several thousand New

England classrooms. It is broadcast by stations WGBH-TV in Boston and by WENH-TV in New Hampshire. The programs are recorded on video tape, and it is planned to make copies of these tapes and kinescopes available to other television stations and school systems that would like to use them. Distribution will be on a nonprofit basis. For further information write: Dr. Charles Walcott, Massachusetts Audubon Society, Drumlin Farm, South Lincoln, Mass.

Scientists in the News

Libbie H. Hyman, research associate in invertebrates at the American Museum of Natural History, received the 1960 Gold Medal of the Linnean Society of London on 24 May during the society's annual meeting. She is the third American and the first woman zoologist to be honored with the society's highest award, which is considered a mark of international distinction in the field of biological research. The medal has been awarded annually since 1888 for outstanding contributions to the natural sciences.

Dr. Hyman has been engaged for nearly 30 years in research and in writing her extensive treatise, *The Invertebrates*. Five volumes have been published and she is now at work on volume 6. When completed, the study will cover the entire field of invertebrate zoology, with special reference to anatomy, embryology, physiology, and ecology. It will be the most comprehensive work in its field ever published in English.

Libbie H. Hyman

The resignation of two members of the Atomic Energy Commission and the appointment of one successor were announced by the White House on 16 May. President Eisenhower named **Loren K. Olson**, general counsel of the commission since 1958, to serve the remainder of the term of **John F. Floberg**, who says that he is leaving "for a complex of reasons, largely personal." Floberg's term expires 30 June 1962.

John H. Williams is the other commissioner who is resigning. He has been ill recently and gave poor health as his reason for leaving. Both resignations are effective 30 June. The Democratic majority of the Congressional Joint Committee on Atomic Energy is expected to demand that a Democrat replace Williams, even if this means delaying action on the appointment of Olson, a Republican.

Two research scientists have been named by the American Heart Association to lifetime posts as career investigators. **Manuel F. Morales**, professor and chairman of the department of biochemistry at Dartmouth Medical School, and **Oscar D. Ratnoff**, associate professor of medicine at Western Reserve University School of Medicine, are the eighth and ninth to receive such appointments. The two men will be given a yearly award for life and will have complete freedom to do research of their own choosing at any institution they wish.

The following men went to Geneva on 12 May to represent the United States in discussions of a research program to improve detection and identification of underground nuclear explosions: **Frank Press** (chairman), director, Seismological Laboratory, California Institute of Technology; **Carl F. Romney**, assistant technical director, Office of Atomic Energy, Department of Defense; **Carlton M. Boyer**, assistant director, Nuclear Research and Reliability, Advanced Research Projects Agency, Department of Defense; **Gerald W. Johnson**, associate director, Lawrence Radiation Laboratory, University of California, Livermore; **Spurgeon M. Keeny, Jr.**, technical assistant, Office of the Special Assistant to the President for Science and Technology; **Richard Latter**, chief, Physics Division, Rand Corporation, Santa Monica, Calif.; and **Robert C. Scheid**, Department of Defense, Washington, D.C.

Milton Gross, director of the department of biochemistry, Margaret Hague Maternity Center, Jersey City, N.J., has received the E. R. Squibb and Sons Prize Paper Award of the American Society for the Study of Sterility for his report on "Cyclic Changes in the Biochemistry of the Female Reproductive Tract."

Elmer G. Butler, an embryologist, has been appointed to the Henry Fairfield Osborn professorship of biology at Princeton University. Butler has been a member of the Princeton faculty since 1926 and was chairman of the department of biology from 1934 to 1948.

Joseph Kaplan, professor of physics at the University of California, Los Angeles, has been presented with the Exceptional Service Award, highest civilian decoration given by the Air Force. The honor was in recognition of Kaplan's leadership in geophysics.

John B. Page will become dean of the Graduate College at Iowa State University on 1 July, succeeding **R. M. Hixon**.

Hixon has been on the Iowa State faculty since 1923, when he was appointed an assistant professor of chemistry. He became head of the department of chemistry in 1944, and from 1948 to 1950 served both in that capacity and as dean of the Graduate College. Since 1950 his responsibilities have been solely those of graduate dean. He will continue on the faculty in research and teaching capacities.

Page, who is dean of the college and dean of the graduate school at Agricultural and Mechanical College of Texas, is internationally known for work in soils physics and soil chemistry. He was one of the first to demonstrate the possibilities of the electron microscope in soil studies.

P. D. Cooper, director of the Virus Culture Laboratory, Medical Research Council Laboratories, Carshalton, Surrey, England, will visit this country for about 4 weeks commencing 4 June to discuss research on tissue culture and the growth of viruses, with particular reference to poliomyelitis. His itinerary includes Washington (4–7 June); Baltimore; Philadelphia; New York; Boston; Detroit; Ann Arbor, Mich.; Minneapolis; Los Angeles; San Francisco; and New York.

George Streisinger has been appointed associate professor of biology in the Institute of Molecular Biology at the University of Oregon, effective 1 September. He will join the Oregon faculty from the Carnegie Institution of Washington, Department of Genetics, Cold Spring Harbor, N.Y. Streisinger's principal present research interest is in the relationship between the structure of a protein (bacteriophage lysozyme) and the structure of the gene which controls its formation.

F. W. G. White, chairman of Australia's Commonwealth Scientific and Industrial Research Organization, will spend 4 weeks in the United States at the end of the summer, after attending a meeting of the Heads of British Commonwealth Research Organizations in England during August.

Arnold Rice Rich, emeritus professor of pathology, Johns Hopkins University School of Medicine, has been awarded the Trudeau Medal of the National Tuberculosis Association for distinguished service in the field of chest diseases.

David Layzer of the Harvard College Observatory has received the Bart J. Bok Prize for research, awarded by the Harvard Department of Astronomy. Layzer was honored for a recent paper on atomic spectra. The study has yielded simple quantitative predictions of the structure of the spectra of complex atoms, in close agreement with experimental findings. The results are immediately applicable to many astronomical, physical, and geophysical problems.

Ernest H. Wiegand is the recipient of the $1000 Nichols Appert Award of the Institute of Food Technologists. Wiegand is the retired head of the food and dairy technology department at Oregon State College.

George P. Murdock, professor of anthropology at Yale University, has accepted appointment as Andrew Mellon professor of social anthropology at the University of Pittsburgh, effective 1 July.

Also at Pittsburgh, **Edward A. Kennard**, of the Anthropological Service of the Veterans Administration, has accepted appointment as professor and chairman of the department of anthropology, effective 1 September.

Ernest H. Volwiler, chairman of the board of Abbott International and a consultant of Abbott Laboratories, North Chicago, Ill., has won the 1960 gold medal of the American Institute of Chemists. He is being honored for his outstanding contributions to the pharmaceutical industry and for his service as a leader in the chemical profession.

Albert B. Sabin has been named the University of Cincinnati's first distinguished service professor, a new designation created to honor Sabin for his research on such virus diseases as poliomyelitis, Japanese B encephalitis, and dengue fever.

Philip C. Hewitt, assistant professor of geology at Union College (Schenectady, N.Y.), will assume the chairmanship of Union's department of geology on 1 July upon the retirement of professor **Edward S. C. Smith**.

James F. Lawrence, former chief of the psychology service in the Boston Area Medical Office of the Veterans Administration, is now national director of the personnel assessment service of Richardson, Bellows, Henry and Co., Inc., New York.

Edgar A. Steck, group leader in the chemical synthetic program of the McNeill Laboratories of Johnson and Johnson, has been named research director of the Wilson Laboratories Division of Wilson and Co., Inc., Chicago.

Andrew V. Haeff, former vice president and director of the research laboratories of the Hughes Aircraft Co., is now a consultant and independent research worker in the fields of electronics and physics.

Robert S. Rowe, professor of engineering at Duke University, will become dean of the School of Engineering at Vanderbilt University in September. He succeeds **Fred J. Lewis**, who died in January 1959; **William H. Rowan**, professor of soil and fluid mechanics, is acting dean.

Johannes H. Bruun, former director of research and development for the Hooker Chemical Co., Niagara Falls, N.Y., is now a member of the product and process evaluation staff of the Agricultural Research Service, U.S. Department of Agriculture.

Recent Deaths

Robert H. Black, University Park, N. Mex.; 42; dean of the College of Agriculture and Home Economics and director of the Agricultural Experiment Station at New Mexico State University; 12 Apr.

Osborne A. Brines, Detroit, Mich.; 66; chairman of the department of pathology at the Wayne State University College of Medicine; president of the International Society of Clinical Pathologists; 18 May.

Gordon O. Cragwall, Garden City, N.Y.; 67; technical director for the Chas. Pfizer Co. of Brooklyn, N.Y.; 28 Mar.

Marlin G. Geiger, Westfield, N.J.; 62; chemical engineer and executive vice president of W. R. Grace and Co., in charge of the eight chemical divisions that make up the Grace chemical group; 13 May.

Philip Hitchcock, Columbia, Mo.; associate professor of surgery in anesthesiology at the University of Missouri; 17 Apr.

Richard J. Lougee, Worcester, Mass.; 55; professor of geomorphology at Clark University; chairman of the geology department at Colby College from 1936 to 47; 16 May.

Jack R. MacCabe, Geneva-Meyrin, Switzerland; 46; senior information officer, European Organization for Nuclear Research; 17 Apr.

Andrew McKellar, Victoria, B.C.; 50; president of the Royal Astronomical Society of Canada and assistant director of the Dominion Astro-Physical Observatory; known for his studies of energy emission by stars; 6 May.

Marion E. Park, Plymouth, Mass.; 84; president of Bryn Mawr College from 1922 until her retirement in 1942; helped to initiate a program of close cooperation—especially in the sciences—among Bryn Mawr, Haverford, and Swarthmore; received honorary degrees from Oberlin, Brown, Swarthmore, Smith, Mount Holyoke, the University of Pennsylvania, and Tufts; 6 May.

Rev. **Albert H. Poetker**, Cincinnati, Ohio; 73; chairman of the physics department at Xavier University, 1950–59, and at Marquette University in 1946, 1950, and 1953; president of the University of Detroit, 1932–39; 6 May.

Walter Schiller, Evanston, Ill.; 72; a pioneer in cancer research and former director of Cook County Hospital Laboratories; 2 May.

Book Reviews

Evolution after Darwin. vol. 2, *The Evolution of Man: Mind, Culture, and Society*. Sol Tax, Ed. University of Chicago Press, Chicago, Ill., 1960. viii + 473 pp. Illus. $10.

This is a rewarding volume for various reasons, the principal one being that the typical contributor is writing on a general topic with which he has previously been identified, but here giving it the best exposition it has had. This would have pleased the great man himself at least as much as the complimentary paragraphs concerning him, with which most of the papers begin, and where, by the nature of their topics, their references to Darwin often end. In fact, many authors make their offering by doing what they do best, like the juggler of Notre Dame, instead of feeling bound to stretch connections with Darwin himself. Such are the papers by von Muralt on the phylogenetic increase of speed in the conduction of nervous impulses, by Howell and Washburn of stages of hominid evolution and the appearance and role of tool-using, by Emiliani on Pleistocene dating by the use of deep sea cores, or by Anderson on the evolution and distributions of domesticated plants. The last two are piquantly unorthodox. Emiliani, using a record of temperature fluctuations, gets a shorter Pleistocene by half than other workers using sedimentation, the astronomical theory, and so forth. Anderson speculates, on the basis of certain more obscure food plants, that Africa was the point of origin of seed domestication, and that influences from this point met, with others from a center of floral plant domestication in Southeast Asia, in the Fertile Crescent to produce the recognized cereal-using Neolithic. Other papers, by contrast with those above, are historical essays (generally on post-Darwin developments): Brosin on psychiatry in terms of evolutionary theory, Hilgard on general progress in psychology of all schools, or Magoun on the phylogeny of functions of the brain.

An important group of writers is concerned with the evolution of human culture. This is the most interesting general aspect of the volume: cultural evolution is no new subject, but the higher sophistication of present day archeology and the fuller knowledge of actual sequences in different areas has put discussion on a new plane. And this symposium, by its nature and title, brings together and juxtaposes a whole series of essays by writers already known for their contributions to the subject. Immediately manifest is a semantic and theoretical difficulty, in the word evolution itself. Evidently because of a feeling that the biologists are the proprietors of the word and that it means *biological* "descent with modification," the historians and anthropologists have always seemed a little shamefaced about using it, when they need not be. The same impulse must lie behind the search for parallels between biological and cultural evolution, a search which would hardly be missing from a book of papers dedicated to Darwin. The search is all right: the revelations of biological evolution are tremendously suggestive, and Darwin is rightly credited with impacts in every direction of thought: he "crystallized the problem of cumulative changes" (Gerard, page 191). It is just that there should be more of a search for the differences, and Kroeber points out that Julian Huxley has specified these differences. It is generally recognized, of course, that biological evolution is by selection of genes, whereas cultural evolution is "Lamarckian" (to get the right connotation with a small illegitimacy), but more might be done by way of definition. The various writers recognize the whole problem, in various degrees, Kroeber most of all, although Adams and others also try to find the chalk line and walk it. Kroeber contends that the study of culture and its history is at a stage that is not merely pre-Darwinian, but even pre-Linnaean, for, as yet, we have neither learned enough of its subject matter nor found the categories necessary to proceed to the kind of formulation that Darwin made. Kroeber might be comforted slightly by those other contributors who are dealing with the actual paleontology of culture—for example, Adams on the emergence of early civilizations generally, and Braidwood and Willey on the evolutionary implications of archeology in the Old and New Worlds, respectively. The happiest of these writers seem to be those least bothered by biological parallels or the traditional baggage of evolutionary ideas. Bordes, in a fine paper on paleolithic cultures, does not even pause to genuflect to Darwin but busies himself at once in a detailed demonstration that even in the Mousterian highly controlled excavation and analysis will reveal a history that may be interpreted not just as "evolution" but as the result of the interplay of culture processes familiar from studies of the ethnographic present. Here is something that reminds one of a paleontologist studying the evolution of the horse in genetic terms. Those contributors, on the other hand, whose papers are addressed more to the theory of the subject (Steward or Piggott) seem always faintly dismayed by the lack of any guiding star which is not biological. Steward hits bottom (on page 269) with "Perhaps the wholesale proclamation of allegiance to cultural evolution in 1959 is principally to do honor to Darwin."

It may be that we will get out of the wilderness when progressing knowledge of the evolution of the brain and behavior, covered in another important group of papers, has done still more to clarify for us the whole biological and psychological basis of culture itself. This is beautifully articulated by Hallowell in a long review. It is probably fair to say that Hallowell, a social anthropologist, has familiarized himself more fully with the work of biologists and physical anthropologists than these latter have really familiarized themselves with culture. He warns that simplistic views of "speech" and "culture" will not allow detection of the socio-psychological variables and the aspects of personality structure which must eventually be analyzed through a phylogenetic and comparative approach.

In a category of its own is Muller's

fascinating sermon on man as the master of his genes. When scientists wax utopian in the ordinary world of politics, we may think of the shoemaker and his last, but when a Nobel Prize winner does it in his own field it is time to listen, however much amazed. Not that Muller would not have first to conquer the political world as well as his own, if we are to expect, with him, "genetic upgrading" by rapidly developing means of insemination or inovulation, or the preservation of sperm or ova of highly selected donors, over generations, for use in manifolding Einsteins, Leonardos, or Lincolns as needed. This may sound like pure science fiction, but Muller is talking about possible things, in the technical sense, and building on a theme that has long occupied him: ways of relief from the population's load of detrimental mutations. Fellow geneticists have reservations, some of which he discusses, but he nevertheless poses a striking contrast between what we might do and what our mores have us do. He definitely does not wish to step out as a leader in a Brave New World, making decisions from the top, but rather to persuade individuals to see the good, where it is good, of raising someone else's seed in place of their own. Pride in biological parenthood and in the perpetuation of personal but inferior genetic endowment, he sees as only one of the sacred cows that would have to be slaughtered. There will be many, and perhaps we will never try his experiments. Perhaps, in spite of Lysenko and his ilk, the Russians will do it first.

W. W. HOWELLS

Harvard University

Evolution and Culture. Marshall D. Sahlins and Elman R. Service, Eds. University of Michigan Press, Ann Arbor, Mich., 1960. xii + 131 pp. $3.75.

If anthropology has a great debate, its subject is the evolution of culture. Still unresolved in many of its major aspects, the whole problem of cultural evolution has, in recent years, undergone something of a sea change: where for a long period the dominant voices were those of the opponents and critics of evolutionary approaches, the present is filled with new sounds of approbation. Yet, when a staunch and longtime supporter of theories of cultural evolution studies the work of some of the more recent contributors, he is often dismayed by its revisionist character, and we are treated to the spectacle of a scholar, who once bemoaned the lack of evolutionary thought among his colleagues, now regretting their adoption of such thought. At the heart of this apparent paradox is the uncertainty and murkiness with which many concepts crucial to the analysis of cultural evolution are beset. *Evolution and Culture* is a major contribution to the task of clearing away some of the deadwood that has accumulated about certain aspects of the manifold problem of cultural evolution.

The four chapters which comprise the heart of *Culture and Evolution* are closely linked but independent works, each by a different contributor. The papers have been slightly edited, but are otherwise unchanged from the versions first read at a symposium held during the 1959 meeting of the Central States Branch of the American Anthropological Association; at the symposium they were greeted with prolonged discussion and the enthusiasm that led to their appearance as a single volume. They are introduced by a foreword by Leslie A. White and by a brief chapter written jointly by Sahlins and Service.

Marshall Sahlins' paper is entitled "Evolution: general and specific." This essay supplies the theoretical *mise en scène* for the other chapters. As the title suggests, Sahlins is primarily concerned with two very different faces of evolution, which he identifies as "specific" and "general." The first of these is explicitly phylogenetic and "interested in how one species grows out of another and how the new species gives rise to still other species." General evolution need not be phylogenetic; at times there may be relative concurrence with phylogeny, but no necessary relation exists between speciation and advance, the fundamental concept on which general evolution rests.

Biologists will associate the distinctions advanced by Sahlins not only with Julian Huxley but with Novikoff and Needham and others who have worried about levels of biological integration. Cultural anthropologists should direct their thoughts beyond the strong voices that nourished cultural evolution during its dark days in this century, beyond the great anthropologists of the second half of the 19th century until they reach such pioneers as Comte, who, as John C. Greene has pointed out elsewhere, was struck by "the recurrence of an identical pattern of historical development in civilizations isolated from each other. The recurrence of this pattern seemed to prove beyond doubt that social evolution was not haphazard but issued inevitably from 'the fundamental laws of human organization' and was governed by 'a natural law of progress, independent of all combinations, and dominating them.' "

The importance of this issue is such that overstatement is difficult. For years anthropology has heard from noted scholars, who would replace Morgan and Tylor's "unilineal" evolution and White and Childe's "universal" evolution with something they call "multilinear" evolution. The argument was further complicated by the fact that careful reading of such a "unilinear" theorist as Spencer revealed no doctrinaire unilinealism but outspoken recognition of the local action of what, since Haeckel, we call ecology. It was further complicated by White's repeated insistence that he was not a "universal" evolutionist but simply an evolutionist, a follower of Tylor and Morgan, though one who had benefited by the decades of research that separated him from his theoretical ancestors. A further complication lies in the question of the relationship between history and evolution: Is evolution, as Kroeber asserts, simply history written large, or, as White assures us, are these two qualitatively different ways of analyzing the same data? Sahlins' viewpoint can be a source of clarification, though less in the area of the difference between history and evolution than in distinguishing the approach of, let us say, Leslie A. White from that of Julian H. Steward. Most importantly, Sahlins enables us to see clearly that Steward's "multilinear" approach is not a substitute for or an improvement on White's, but something very different. Furthermore, as briefly suggested above, the difference was recognized, at least implicitly, by the 19th-century theorists who *chose* to investigate general evolution.

The next chapter, "Adaptation and stability" (by Thomas G. Harding), investigates a central aspect of the process of specific evolution. Crucial to Harding's argument is the recognition of the distinction between the two kinds of evolutionary analysis: adaptation per se is a mechanism of specific, not of general, evolution. In Harding's words, "One of the major consequences of adaptation for culture as a whole has been the production of cultures in particular, the production of diversity"

(page 50). Harding emphasizes ecology, which he defines as embracing "the relations between cultures, the superorganic setting, as well as the natural features of the habitat." He also sets the stage for Service's later chapter by noting that in culture, as in biology, adaptation frequently involves specialization and attendant conservatism. Successful occupation of an ecological niche is correlated with stability; advance in a given phylogenetic line may be stymied by success.

In logical sequence, the next chapter, "The law of cultural dominance" (by David Kaplan), explores a phenomenon, the mere existence of which gives a powerful tool to those who would push beyond relativism. Biologists, at least since Darwin, have noted that at particular times certain forms have been conspicuous for their numerous varieties, for their apparent prolificacy, or for the wide range of environments they exploit. A similar phenomenon exists with reference to culture: certain cultures or culture-types appear to be dominant and show their dominance not merely in biological terms of population, but in such culturological terms as the direction of acculturative change and the replacement of one culture by another in specific localities.

Kaplan recognizes that the phenomenon of dominance has two facets which may be viewed in different perspective; these accord with the previous distinction between specific and general evolution. The former kind of dominance is associated with the process of adaptation, as discussed by Harding. Kaplan agrees that such dominance is related to increasing specialization, to competitive success in the exploitation of a specific environment. But, says Kaplan, "if specific evolution leads to increasing *adaptation* . . . general evolution leads to greater *adaptability*" (page 70). General dominance is then linked to successive widening of the ecological horizon, this process being based upon what Kaplan calls "new biological inventions," for example, "improvements in temperature regulation, prenatal protection of the young, and a number of other features . . . which make it possible . . . to function effectively under a much wider range of environmental conditions" (page 71).

Kaplan enunciates the "law of cultural dominance": "that cultural system which more effectively exploits the energy resources of a given environment will tend to spread in that environment at the expense of less effective systems" (page 75). Though freshly stated, Kaplan's generalization resembles those of White and Cottrell (whom he cites). It also returns to an important theme in Sahlins' chapter, namely, the attempt, following Lotka and similar theorists, to subsume cultural evolution under the great rubric of energy transformation, a theme well known in the work of Leslie A. White, who credits Ostwald with the distinction of having been a pioneer in this area.

The fifth and final chapter of *Evolution and Culture* is "The law of evolutionary potential" (by Elman R. Service). Weaving together some of the implications of the previous essays and his own views of evolutionary process, Service states the generalization for which his paper is named: "The more specialized and adapted a form in a given evolutionary stage, the smaller is its potential for passing to the next stage." He then states a startling corollary: "Specific evolutionary progress is inversely related to general evolutionary potential" (page 97).

As in the essays of Harding and Kaplan, and to a lesser extent Sahlins, the main points are illuminated with briefly sketched ethnographic data. In giving examples, Service is careful to avoid creating the impression that he wishes (as a historian of science has put it) "to explain the assumed development by means of a few judiciously selected principles supported by an assortment of judiciously selected facts." Service admits that illustrations are not proof. Instead, he asks that the principles enunciated in this book be judged on the basis of their utility or their explanatory value rather than on the basis of their absolute truth.

Each of the essays in this book has its share of controversial features, but Service's chapter will probably provoke the largest number of general readers, for he applies his principle of evolutionary potential to the present sociopolitical situation. He suggests that the present world posture of the United States represents that of an overspecialized, overadapted culture—one that he predicts will have great difficulty getting over the divide that represents the next general stage in the evolution of culture. To head off disaster (from our point of view), it will be necessary to encourage all of the processes that are bringing new cultural forms to the fore, even if this means hastening our fall from the position of dominance presently enjoyed.

Having stated some of the most important theses contained in this book, it seems proper that I make some evaluation more specific than mere allusion to its possible effect as a stimulant. Certainly the distinction between specific and general evolution is of great importance, though it has been neglected by biologists and often denied by anthropologists. With regard to specific evolution, it should be noted that "adaptation" is much less satisfying as a mechanism when applied to culture than when applied to biology. Underlying adaptation in biology is natural selection, which operates through differential reproduction—ultimately through life and death. But in dealing with culture we must not place too much emphasis on simple demography, lest the differential viability of populations be confused with the differential viability of cultures.

Related to this, and of equal importance, is the problem of the mechanism of general evolution. Sahlins dips directly into Lotka and comes up with "total energy flux." But this raises many questions with regard to which I share Sahlins' lack of *expertise*. Thus, Sahlins is unequivocal in stating that "general progress is not to be equated with thermodynamic *efficiency*" (page 34). He prefers to regard, as his index of advance, the amount of energy trapped by an organism and converted to "a higher state," for example, from inorganic to organic compounds, or from the latter state into protoplasm. According to such a scheme, the presumptive index of biological advance would be metabolic, and a creature such as the shrew would represent a peak of energy flux and, therefore, a very advanced type, relative to other mammals.

A critical point that may be addressed to all the papers concerns the unit of analysis. It is not clear in any given paper, still less in the volume as a whole, what constitute the boundaries of the units under consideration. Difficult as this problem may be in the biological sciences, there is no comparing the discreteness of a particular organism, or even of a breeding population, with the fluidity of a culture or the amorphousness of a culture area. Though the definition of a biological species is essentially arbitrary, it has greater consistency in logic and in procedure than most definitions of cultures or culture types. It is not in criticism of these essays that I raise this problem, for it is beyond their scope to treat it.

Nevertheless, I note that the suggestions of the various contributors will suffer a lack of clarity and precision until the units involved are more specifically bounded.

Related to this point is a final comment addressed to the Service paper: *If* it is true that China, enjoying "the privilege of historical backwardness," is on the verge of a great leap forward, which (due to the "law of proportional development" so hotly discussed by the economists of Mainland China) will place China ahead of both the United States and the U.S.S.R., it is at least equally true that, until a bare 150 years ago, China was representative of a dominant culture capable of assimilating most others or, at least, of shrugging them off. Obviously the "law of evolutionary potential" does not, under present conditions, favor the truly backward and unspecialized cultures, but only those which have temporarily dropped a stride behind the leaders.

Although brief, *Culture and Evolution* is a valuable work that merits a wide readership, not only among anthropologists but among biologists and those in the physical sciences as well. Compliments to these bold authors; I hope that they have whipped up a storm, initiated a debate that will cross disciplinary lines and, perhaps, lead on to a more triumphant synthesis.

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I.C.A.R. Monographs on Algae. No. 1, *Zygnemaceae*. M. S. Randhawa. 478 pp. Illus. Rs. 26. No. 2, *Cyanophyta*. T. V. Desikachary. x + 686 pp. Illus. Sh. 72. Indian Council of Agricultural Research, New Delhi, 1959.

These excellent monographs constitute the first steps in the realization of an ambitious and commendable project undertaken by the Indian Council of Agricultural Research: the comprehensive taxonomic treatment of all groups of Indian algae. Randhawa's *Zygnemaceae*, however, is much more than a local floristic account. He treats this sharply defined group of fresh-water algae on a world-wide basis, recognizing 580 species in 13 genera, of which 174 species in 9 genera have so far been recorded from India. Most of the many species originally described from India have not yet been found elsewhere. Randhawa's task, on first consideration, would seem formidable, but was made possible (as he acknowledges) by the existence of several monographs on this group; the most recent was the monograph by Transeau (1951), who recognized 534 species in 13 genera. Part of the increase in the number of species recognized by Randhawa is due to the publication in the present work of 14 new species identified by M. O. P. Iyengar (unfortunately these species are invalidated by lack of Latin diagnoses). Randhawa follows the example of Kolkwitz and Krieger in providing chapters on occurrence and geographical distribution, cytology, and reproduction, in addition to an interesting introductory account of the history of phycology with special reference to the Zygnemaceae and to India. But the fact that Randhawa had excellent models to guide him should not diminish the high praise that he deserves for producing a first-rate work which retains the best features of existing treatments and enhances the subject by consistent and accurate bibliographic documentation and by incorporating the results of recent investigations.

Desikachary's monumental treatment of blue-green algae is limited to India and its neighboring countries, largely because of the size of the group: the number of species recognized is about 750, representing 85 genera. The systematic account is preceded by a welcome discussion of the cytology, morphology, reproduction, ecology, and phylogeny of Cyanophyta. Steering a middle course between Drouet and Elenkin, Desikachary accepts Fritsch's scheme of classification with certain modifications. Several new taxa are described. The illustrations, mostly redrawings, generally are satisfactory, but some are sketchy. The bibliographic documentation is thorough and accurate.

Both authors write in a clear and pleasing style. The books are well manufactured, although the bindings may not be strong enough to support the weight of the high-quality paper. The Indian Council of Agricultural Research and the authors are to be congratulated on these scholarly achievements, which bring to public attention the prominent rôle that Indians play in phycological research.

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The Mysterious Earth. Lester del Rey. Chilton, Philadelphia, Pa., 1960. xii + 214 pp. $2.95.

You and the Universe. N. J. Berrill (with support from Walt Whitman). Dodd, Mead, New York, 1958. viii + 215 pp. $3.50.

The Forest and the Sea. A look at the economy of nature and the ecology of man. Marston Bates. Random House, New York, 1960. 277 pp. $3.95.

These three books are all concerned, in one way or another, with man's place on the planet or in the universe. Lester del Rey's book is a factual popularization of material about the earth and life, apparently summarized for the most part, from *Scientific American* articles. It is for brighter young people and will serve a useful purpose, although it might have been improved by some illustrations.

N. J. Berrill, a zoologist turned philosopher, wants to know "just what are we doing here, spinning on a tilted planet swinging round a star" and examines the nature of the planet and the life on it in chapters with themes set by quotations from Walt Whitman. It is the sort of book intended for those fascinated with the "Wonder Of It All," pinnacled, as Shelley said somewhere, deep in the intense inane.

The book by Marston Bates is something else again, an attempt to bring to the reasonably educated man the essence of ecology, and of man's place in nature, in the ecological rather than in the philosophical-evolutionary sense. It is a significant, careful treatment that deserves to be widely read by all who are concerned with nature and with where man's bread is to come from. However, it is not a plundered planet book except, perhaps, by implication, but an original treatment of what might best be called general ecology.

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Introduction to Theoretical Meterology. Seymour L. Hess. Holt, New York, 1959. xiv + 362 pp. Illus. $8.50.

This is a very useful addition to the list of meteorological textbooks. It has many didactic merits. In particular, the attempt to deduce the complex atmospheric conditions from basic physical

principles is praiseworthy. It is also quite refreshing to see the importance of dimensional analysis called to the attention of meteorologists, quite a few of whom seem to ignore it. The innovation of using a list of symbols as end paper for the book is appealing.

The treatise proceeds, in logical form, from the principles of thermodynamics, hydrodynamics, and radiation to the problems of atmospheric motion. These are dealt with in an up-to-date fashion. There is a welcome excursion into the important field of turbulence. The book culminates in a discussion of numerical "weather" prediction (at present still a distinct misnomer) and ends with an approach to the explanation of the general atmospheric circulation. This terminates with Philipps' already classical numerical experiment of 1956.

Quite disappointing is the treatment of condensation and precipitation problems. The theory has certainly advanced beyond static saturation. Although Hess deliberately tried to avoid vector notation, I doubt whether this really simplifies things beyond a certain formal point for the student. Even the more elementary mathematical treatment will not make theoretical meteorology into a "snap" course. The effort required to solve the problems, which the author has appended to each chapter, will convince the beginner of that.

The book is very well illustrated and produced. One can wish it a long and successful run.

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Approach to Archaeology. Stuart Piggott. Harvard University Press, Cambridge, Mass., 1959. x + 134 pp. Illus. $3.

This is the newest in a series of books written by archeologists of the British Isles and designed to interpret the methods and results of archeology. Like the others, it is aimed at capturing the interest of the general reader. Stuart Piggott's work focuses on process and on the nature of archeological evidence rather than upon results.

The discerning reader will find much that is useful in this study. Topics range from archeology as a discipline; the methods and techniques of detection, recovery, and identification; and the construction of time-scales to the relationships of archeology to prehistory and history. In the latter instance the discussion centers on societies which left documentary and literary records and those which did not—text-free and text-aided archeology—as the basis for establishing the role of archeology. This distinction is far more emphatically made in Europe than in America, for in the New World the literary record is scant, and the dividing line between history and prehistory is less complicated. The important point, of course, is that the techniques of archeology are all that we have to shed light on certain aspects of societies, whether old or young, simple or complex, and whether literate or not. The distinction, therefore, is largely academic.

The disappointing feature of this book is its regional bias and the avoidance of recognizing contributions made by New World archeologists to the approach to the discipline. Tree-ring dating is briefly mentioned, but its regional applications, its potentiality, and its impact on time-scale building are not explored. Archeological reconnaissance as a means of testing the resources of an area and as a basis for formulating problems is ignored. Surely American archeologists have made relevant contributions to analytical procedures, to concepts of type and tradition, to settlement pattern studies, to epigraphy, to the interdisciplinary approach demanded by the deficiencies in the archeological record, and to fundamental digging procedures. All of this might be forgiven if it were not for the fact that the final section, "Suggestions for further reading," replete with excellent citations, does not include a single reference on New World archeology. The boycott appears to be intentional. It is all the more surprising, therefore, that the Harvard University Press produced the book to capture the American market. Had this book carried the title "A British Approach to Archaeology," the tenor of this review would have been quite different.

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Reprints

Baker, Robert H. *When the Stars Come Out.* Viking Press, New York, rev. ed., 1960. 182 pp. $1.25.

Bridgman, P. W. *The Logic of Modern Physics.* Macmillan, New York, 1960. 242 pp. $1.25.

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Cowling, T. G. *Molecules in Motion.* Harper, New York, 1960. 183 pp. $1.45.

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Miscellaneous Publications

(Inquiries concerning these publications should be addressed not to Science, *but to the publisher or agency sponsoring the publication.)*

Basic Research Résumés. A survey of basic research activities in the Air Research and Development Command. Office of Technical Services, Washington 25, 1960. 334 pp. $3.

Boletin de Geologica No. 3. Facultad de Petroleos, Departmento de Geologia, Universidad Industrial de Santander, Bucaramanga, Colombia, 1959. 77 pp. $3.50.

Forest, Wildlife, and Recreational Resources. Atlas of Illinois resources, section 3. Division of Industrial Planning and Development, Springfield, Ill., 1960. 46 pp.

A Long-Range Forecast of United States Precipitation. Miscellaneous Collections, vol. 139, No. 9. C. G. Abbot. Smithsonian Institution, Washington, D.C., 1960. 78 pp.

National Interests in Antarctica. An annotated bibliography. Compiled by Robert D. Hayton. U.S. Antarctic Projects Officer, Washington, D.C., 1959 (order from Supt. of Documents, GPO, Washington 25). 137 pp. $1.25.

Public School Finance Programs of the United States, 1957–1958. Misc. No. 33. Albert R. Munse and Eugene P. McLoone. U.S. Office of Education, Washington, D.C., 1960 (order from Supt. of Documents, GPO, Washington 25). 283 pp. $2.

Reports

Density of the Lunar Atmosphere

Abstract. The minimum possible density of the lunar atmosphere at the surface is shown to be essentially the value for the interplanetary medium. This value, when combined with the observed maximum, places the particle density between 10^5 and 10^6 per cubic centimeter, while the electron density must be about 10^3 to 10^4 per cubic centimeter. These results are markedly different from those recently obtained by Firsoff.

It has long been known that the lunar atmosphere must be very tenuous (*1*), as is indicated in many ways, including observations of the moon near the lunar cusps (*2*). In 1952, Dollfus (*3*) established an upper limit for the density of the lunar atmosphere of 10^{10} particles per cubic centimeter from polarimetric observations. This value remained the upper limit for the lunar atmosphere until 1956, when the limit was lowered by a factor of 10^4 from radio observations of a lunar occultation of the Crab nebula (*4*). Öpik (*5*) has pointed out that the radio method is about 10^4 times more sensitive than the polarimetric method, and hence it is interesting that the upper limit of the lunar atmosphere has been lowered by the amount of the increased precision. It may then be illustrative to assume (following Öpik) that the moon has no exhaled atmosphere of its own but that the lunar atmosphere is simply a gravitational condensation of the interplanetary medium. We may then calculate the lower limit for the density of the lunar atmosphere.

An isothermal atmosphere in hydrostatic equilibrium about the moon follows the density law,

$$N(r)/N(r_0)=\exp\left[-\frac{G\mathscr{M}M}{kT}\left(\frac{1}{r_0}-\frac{1}{r}\right)\right] \quad (1)$$

where M is the mean mass per particle, k the Boltzmann constant, G the gravitational constant, $\mathscr{M}$ the mass of the moon, T the atmospheric temperature, and r the distance from the center of the moon, r_0 being the lunar radius. This distribution reaches a limit for $r \gg r_0$, and if we can observe the density at large distances from the moon, we can then calculate the density at the surface. The quantity of interest is $N(r_0)/N(r=\infty)$. For the moon, Eq. 1 yields

$$N(r_0)/N(r=\infty)=\exp\left[\frac{340}{T}\mu\right] \quad (2)$$

where μ is the mean molecular weight of the atmosphere. The interplanetary medium may be regarded as a tenuous extension of the solar corona and hence as a proton-electron gas of molecular weight ½. The temperature of the ionized lunar atmosphere (gravitationally condensed from the interplanetary medium) will be nearly isothermal at essentially the temperature of the interplanetary medium itself. The temperature in the vicinity of the orbit of Earth can be calculated from consideration of the properties of a solar exosphere. In a recent investigation, Chamberlain (*6*) has shown that the temperature of the interplanetary medium at the orbit of Earth is between 10,000 and 100,000°K, depending on the number of high velocity particles available at the base of the exosphere. With the values of μ and T mentioned above, we find from Eq. 2 that $N(r_0)$ is, at most, a few percent higher than $N(r=\infty)$. Since $N(r=\infty)$ can be shown in a variety of ways (*7*) to be $\approx 10^5$ particles per cubic centimeter, we may combine this value with the observed upper limit to show that the density of the lunar atmosphere at the surface must be between 10^5 and 10^6 particles per cubic centimeter. From the radio observations an upper limit for the electron density at the surface of the moon of 10^3 to 10^4 per cubic centimeter was derived. This allows us to infer that the electron density is near 10^3 to 10^4 per cubic centimeter, and also to place limits on the number of electrons that the exhaled component of the lunar atmosphere can add to the interplanetary component (*8*).

In a recent investigation, Firsoff (*9*) has also made a calculation of the minimum density of the lunar atmosphere arising from the concentration of interplanetary gas. He obtains a value for $N(r_0)$ of 10^7 particles per cubic centimeter, which is above the observed upper limit by a factor of 10. His value is clearly erroneous since he uses a mean molecular weight of 25 and a temperature of 250°K. These values may apply to an exhaled lunar atmosphere but certainly do not apply to an atmosphere condensed from the interplanetary medium. Equation 2 for $\mu=25$ and $T=250$°K gives a value for $N(r_0)$ of 6×10^{17} particles per cubic centimeter. This value differs from Firsoff's value because Firsoff cuts off the lunar atmosphere 1000 km above the lunar surface, and because he has made some numerical errors; for example, he has used a value for the radius of the moon which is too small by a factor of about 2. Firsoff also discusses three "important factors" which he claims have been neglected in the theory of dissipation of planetary atmospheres. His first factor is inherent in the concept of the base of an atmosphere, his second factor is incorrect (*10*), and his third factor is well known (*5*).

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25 November 1959

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

Learning and Cortically Evoked Movement during Propagated Hippocampal Afterdischarges

Abstract. Learned responses are absent during intense hippocampal discharges. Their absence is attributable not to a disruption of learning but to an effect upon the motor system.

The hippocampus and the cerebral structures related to it (the limbic system) have been implicated as the anatomical substrate of such behavior as emotion (*1*), memory and recall (*2*), and drive states (*3*). Hippocampal afterdischarges were used in this study to investigate the functions of this system. A hippocampal afterdischarge consists of high-amplitude electrical potentials that continue in the brain for as long as 90 seconds after the initiating electrical stimulus has ceased. Although a hippocampal afterdischarge begins in the hippocampus, it does not remain confined to it but propagates to other limbic structures, without ordinarily involving the neocortex. The immediately observable effects of a propagated hippocampal afterdischarge are few, despite the intense electrical activity of the brain. Learning techniques were therefore used to try to ascertain what was happening.

Conditioned cardiorespiratory responses and conditioned leg movement, learned prior to induction of afterdischarges, were absent during well propagated hippocampal seizures (*4*). However, if only one hippocampus was intensely involved, the responses were not markedly disrupted. One possible explanation of the disruption of the learned response during the afterdischarge is a deficit on the motor side. This appeared unlikely in view of the brisk leg movement, and the concomitant change in heart rate, evoked by an electric shock to a paw during the afterdischarge. On the other hand, the deficit did not appear to be sensory, since evoked potentials continued to appear at the auditory cortex during afterdischarges. It seemed reasonable therefore to hypothesize that it was the coupling of the sensory stimulus and the conditioned response that was disrupted. This view conforms with the assignment to the hippocampus of memory and other functions considered essential to learning. The hypothesis could be tested by determining whether or not animals could learn if their only learning trials took place during afterdischarges.

Seven cats were trained exclusively during hippocampal afterdischarges to lift a paw to avoid a shock. The animals had electrodes implanted aseptically in both hippocampi, in the neocortex, and in various relevant subcortical structures. The sites of the electrode tips were determined histologically. The afterdischarges were customarily elicited by a train of 62.5-pulse/sec, 2-ms biphasic square waves lasting 10 seconds or less, whose peak-to-peak current was usually about 0.3 ma. The duration of the afterdischarges varied from 10 to 90 seconds, and one to four learning trials were given during a single afterdischarge depending upon its duration. Each trial consisted of a 2.5 second, 62.5-pulse/sec auditory sawtooth wave whose intensity was approximately 93 db relative to 0.0002 dyne/cm^2, followed by a 0.5 second shock to the foot which was terminated or avoided by the cat's raising his right hind paw. The cat was suspended in a holder that restrained its movements. This restriction permitted electroencephalography with few movement artifacts. Bipolar electrical recordings were obtained throughout training and testing for learning.

Prior to the actual learning sessions, the auditory signal alone was tested for its effectiveness in eliciting a discrete leg response. No such responses occurred to the sound alone, either in the presence or absence of afterdischarges. During the actual period of training, which took place only during the afterdischarges, three of the cats (1, 2, and 3 in Fig. 1) seldom avoided the shock, although a few discrete avoidance responses appeared. In these cats the afterdischarges were well propagated to both hippocampi. In trials after the hippocampal afterdischarges were discontinued, these animals all responded at levels so high as to indicate that learning had already taken place. Five additional cats were trained in a fashion identical to that of the experimental animals except that the training took place without afterdischarges being induced. In the first 100 trials none of them showed a level of learning comparable to that of the experimental animals when no longer given afterdischarges. When one computes the percentage response for each block of 20 trials for each cat, the maximum response achieved by any cat does not exceed 35 percent in any block up to the 100th trial. The maxima for the other cats are 15, 5, and 0 percent. Had the experimental animals learned only during the trials following the discontinuance of the afterdischarge, their percentage avoidance response should have been no higher than that of these controls. The data thus indicate that learning took place during the afterdischarges.

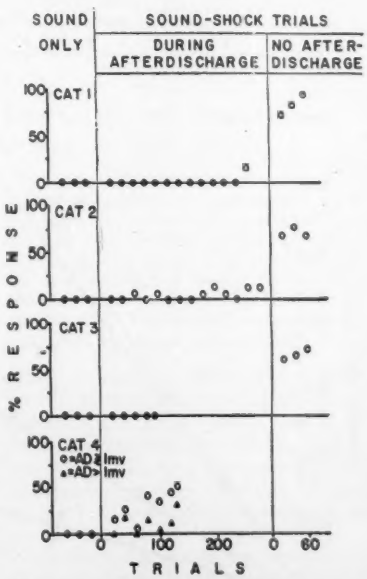

Fig. 1. Learning during afterdischarges in the relative absence of performance (cats 1, 2, and 3). Performance may also take place if afterdischarges are not intense, and occasionally even during intense afterdischarges (cat 4).

Table 1. Increase in latency and decrease in magnitude of cortically elicited movements during afterdischarges as compared to movements elicited in their absence. All differences significant at $P < .001$.

Cat	Mean ± S.D.*	N
	Increase in latency (sec)	
A	0.37 ± 0.07	24
B	0.18 ± 0.04	23
C	2.16 ± 0.25	29
	Decrease in magnitude (mm)†	
A	6.06 ± 0.49	24
B	1.77 ± 0.19	26
C	3.30 ± 0.45	38

* S.D., standard deviation of the mean. † 1 mm recorded response = 12.5 mm actual movement.

In two of the cats the afterdischarges were not well propagated to both hemispheres, and these animals showed discrete anticipatory leg responses during the afterdischarges. The graph at the bottom of Fig. 1 shows the anticipatory responses made by one of these cats. The data are plotted irrespective of the magnitude of the afterdischarge, and also when only afterdischarges in excess of 1 mv are present. The relative number of responses during intense afterdischarges is small, in agreement with the results in the other animals.

In two of the animals no evidence of learning was obtained. In both these cats grand mal seizures were regularly precipitated. This may account for their failure to learn. The tendency to develop grand mal seizures increased in the course of inducing hippocampal afterdischarges in all the animals. In

the two just mentioned grand mal seizures were particularly common.

Since it was evident from the data of the experiment just described that the failure to elicit a conditioned response during a well propagated hippocampal afterdischarge was not due to the actual disruption of the coupling between the conditioned stimulus and the conditioned response, the motor side of the phenomenon was subjected to closer scrutiny. Electrodes were implanted in the motor cortex so that electrical stimulation would elicit a movement of the forepaw. Electrodes were also placed in both hippocampi. After the animals had fully recovered from the effects of the operation, the magnitude and latency of cortically evoked movement were determined in the presence and absence of propagated hippocampal afterdischarges. The results of this study are shown in Table 1. The latency of the cortically evoked movement increases during hippocampal afterdischarge, and correspondingly the magnitude of the movement decreases. Although all the cats show differences in the same directions, the magnitudes of the differences are not the same. In order to record the movements in the chronic preparation it was necessary to use a weight to bring the forepaw to a consistent starting point. This, together with other differences such as the strength of the cat, the placement of the electrodes, and threshold values, probably accounts for the observed differences between animals.

The occurrence of learning during hippocampal afterdischarges renders unlikely the thesis that the hippocampus is the main recording system of experience. It also makes improbable the supposition that hippocampal afterdischarges are responsible for the amnesia of epilepsy or shock treatments. The decrease in the cortically evoked motor response during hippocampal afterdischarges provides an explanation, at least in part, of the disruption of the learned response during such seizures (*5*).

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20 January 1960

Scintillation Counting of Beta Activity on Filter Paper

Abstract. Scintillation counting of beta activity on filter paper, with monoisopropylbiphenyl as a solvent of low volatility, was investigated. The method is attractive since no sample preparation is involved, and the activities are measured directly on the filter paper wetted with the scintillator solution. A linear dependence of counting rate on total activity was found for iodine-131, phosphorus-32, sodium-22, and carbon-14, and counting efficiencies were determined.

Radioactive samples are frequently collected on filter paper during the processes of separation or purification of labeled material. Direct scintillation counting of the sample on filter paper is feasible (*1*). Such a procedure circumvents difficulties arising from insolubility of the sample in aromatic liquid scintillation solvents. Although it is usually possible to synthesize the sample into a form soluble in a liquid scintillator (*2*), or to incorporate small amounts of aqueous solution in a liquid scintillator (*3*), these methods are indirect and time consuming, and they frequently result in a marked decrease in the fluorescence efficiency of the solution with a concomitant reduction in the absolute counting efficiency.

It is patently advantageous to assay the activity of the sample with a minimum amount of purification or special preparation. In varying degrees, suspension of the active material in gels (*4*), or thickened systems (*5*), or the use of plastic capillary detectors (*6*) to count aqueous solutions of beta emitters, achieves this desired result.

An alternative technique (*1*) is to wet a filter paper containing an active deposit with a liquid scintillator solution. The organic solvent renders the paper relatively transparent, and surprisingly good light collection is possible. The method suffers from the evaporation of the solvent on a warm phototube surface and this results in a change in solute concentration with an accompanying change in detection sensitivity.

In order to overcome this weakness in the method, monoisopropylbiphenyl, which was recently reported as a scintillation solvent by Swank (*7*), was tested for its suitability for filter paper counting. This solvent possesses a vapor pressure about 1/1000 that of toluene at room temperature, and has a correspondingly lower rate of solvent loss by evaporation.

To test the counting method, samples of beta emitters of differing energy were chosen. A series of aliquots of aqueous solutions of calcium-14, sodium-22, iodine-131, and phosphorus-32 were pipetted onto No. 1 Whatman filter paper 1⅜ inches in diameter. The

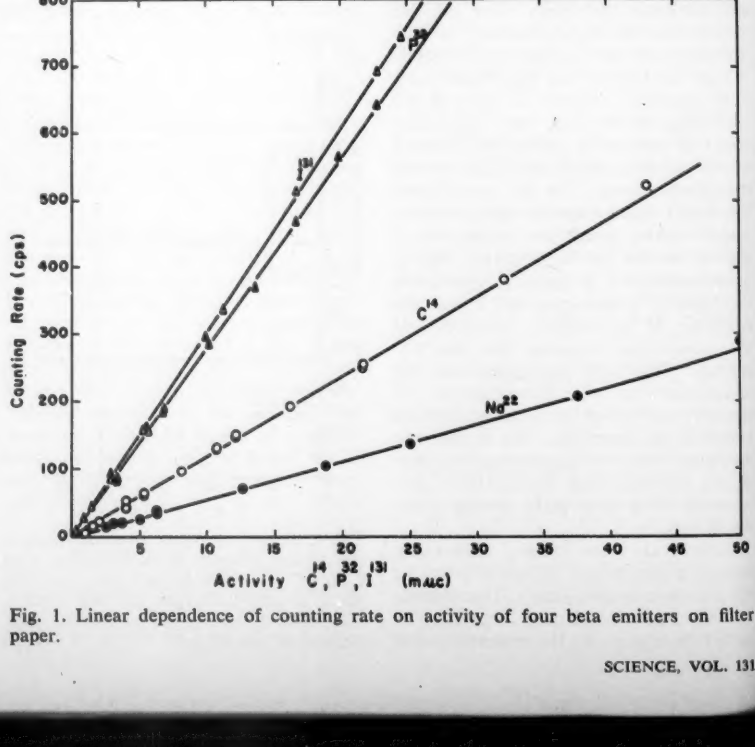

Fig. 1. Linear dependence of counting rate on activity of four beta emitters on filter paper.

isotopes have maximum beta energies of 0.155, 0.542, 0.608, and 1.70 Mev, respectively. The volumes of aqueous solution employed were in the range of 25 to 100 μl. The active filter papers were dried and then wetted with a liquid scintillator solution containing *p*-terphenyl (4.0 gm/liter) and 1,4-di-(2-(5-phenyloxazolyl))-benzene (POPOP) (0.1 gm/liter) in monoisopropylbiphenyl. The solvent was purified by washing with concentrated H_2SO_4, followed by 10-percent NaOH solution, and successive washings with pure water. It was then dried over $CaSO_4$, treated with chromatographic alumina, and vacuum distilled at 4 mm at 135° to 136°C.

The impregnated filter paper was placed on the surface of a Dumont 6292 photomultiplier tube, covered with aluminum foil, and counted on a scintillation counting assembly, without phototube refrigeration or anticoincidence circuitry. A linear amplifier and an integral pulse height selector, set at the lowest level commensurate with tolerable photomultiplier noise, were employed.

The data are succinctly illustrated in Fig. 1, where it can be seen that a linear dependence of counting rate on the activity of the sample is obtained. The absolute activity of the stock solution was checked and calibrated by internal liquid scintillation counting. This permitted the determination of counting efficiencies for the various isotopes under the conditions of measurement. The background counting rates were consistently in the region of 0.7 to 0.8 count per second, and the counting efficiencies, in percentage, were as follows: I^{131}, 83; P^{32}, 78; Na^{22}, 76; and C^{14}, 31.5.

The lower efficiency for P^{32} was believed due to incomplete capture of the energy in the thin layer of scintillator employed. In order to investigate the effect of thickness of scintillator solution, a series of experiments was conducted in which a petri dish was placed on the photomultiplier tube and the filter paper was suspended horizontally parallel to the tube face between a series of narrow metal rings of ¼ inch wall thickness. With rings of varying depth the thickness of the layer of liquid scintillator above and below the filter paper could be varied. The detection efficiency for P^{32} increased with added depth of scintillator solution to a maximum of 96-percent with a volume of 3.5 ml.

This method of filter paper counting has the additional advantage of preventing possible contamination of the photomultiplier face.

The results indicate that direct filter paper counting can be employed as a technique for rapid and reproducible measurement of small quantities of low-energy beta emitters, with good detection efficiency and minimum sample preparation, and is particularly valuable for the measurement of inorganic compounds which are not readily soluble in organic solvents.

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25 February 1960

Late Glacial and Postglacial Hudson Bay Sea Episode

Abstract. Geological investigations, archeological studies, and radiocarbon dates indicate a similarity of events around Hudson Bay, commencing at the time Hudson Bay Basin was freed of glacier ice. The sea that then spread around Hudson Bay 7000 to 8000 years ago is here named "Tyrrell Sea." The subsequent rate of land emergence decreased exponentially.

Recent studies of Pleistocene deposits around Hudson Bay, including ice recession and marine overlap studies by Bird (*1*), archeological studies by Rainey and Ralph (*2*), and ice recession and stratigraphic studies by Fyles (*3*) and by me (*4*, *5*), suggest a correlation of events.

This region is within the central zone of the maximum Wisconsin ice sheet. It was greatly downwarped during occupation by the ice, was flooded during ice recession, and later partly emerged as upwarping progressed. The dominant marker in these events is the marine submergence, to which the name "Tyrrell Sea" is here given.

The Tyrrell Sea reached its maximum extent 7000 to 8000 years ago, as indicated by radiocarbon ages obtained on shells collected from near the highest strand lines west and south of the bay. The age of 6975 ± 250 years was obtained on shells from west of Hudson Bay (*4*) (site 1 in Fig. 1), and south of the bay ages of 7875 ± 200 and 7280 ± 50 years were obtained on shells collected by O. L. Hughes from sites 2 and 3 in Fig. 1 (the various laboratories engaged in this work are listed in the figure legend). Dates are not yet available for the east coast of Hudson Bay. Comparative ages on other Pleistocene seas outside of the central zone of the maximum Wisconsin glaciation are: about 10,000 to 11,000 years before the present (B.P.) for the Champlain Sea episode (*6*) and 13,325 years for the marine overlap along the Atlantic Coast, near Saint John, New Brunswick [dating index I (GSC) 7]. The latter date is on shells I collected from beds of marine clay which were overlain by deltaic gravels.

The advance of the Tyrrell Sea into the Hudson basin shaped the direction of the last ice recession. These shifts of glacier flow are recorded both west and east of Hudson Bay in the distribution of erratics and the orientations of drumlins and striations (*4*, *5*). The former positions of the ice-sea contacts are recorded in distinctive drift ridges, termed by me straight-ridged minor moraines for the region west of the bay (*4*) and washboard moraines for the region east of the bay (*5*). I have since studied the classical area of washboard moraines in the Chibougamau region of Quebec (*7*), and they all appear to have had a similar origin. These shifts of flow and washboard moraines indicate similar ice-sea conditions both west and east of the bay.

Upwarping of the land began upon removal of the load of the ice sheet, and caused a regression of the Tyrrell Sea. Radiocarbon dates on shells, wood, and bones collected from the marine deposits at known elevations around Hudson Bay give information on the rates of this land emergence. The highest shore lines, about 800 to 900 feet above present sea level, are recorded east of Hudson Bay (*5*), in contrast to about 400- to 600-foot elevations west of the bay (*3*, *4*). This difference in elevation is due either to greater rebound east of Hudson Bay, where the ice sheet had been thicker, or to greater, unrecorded uplift having taken place west of Hudson Bay before the highest shore lines were formed. The information on emergence is summar-

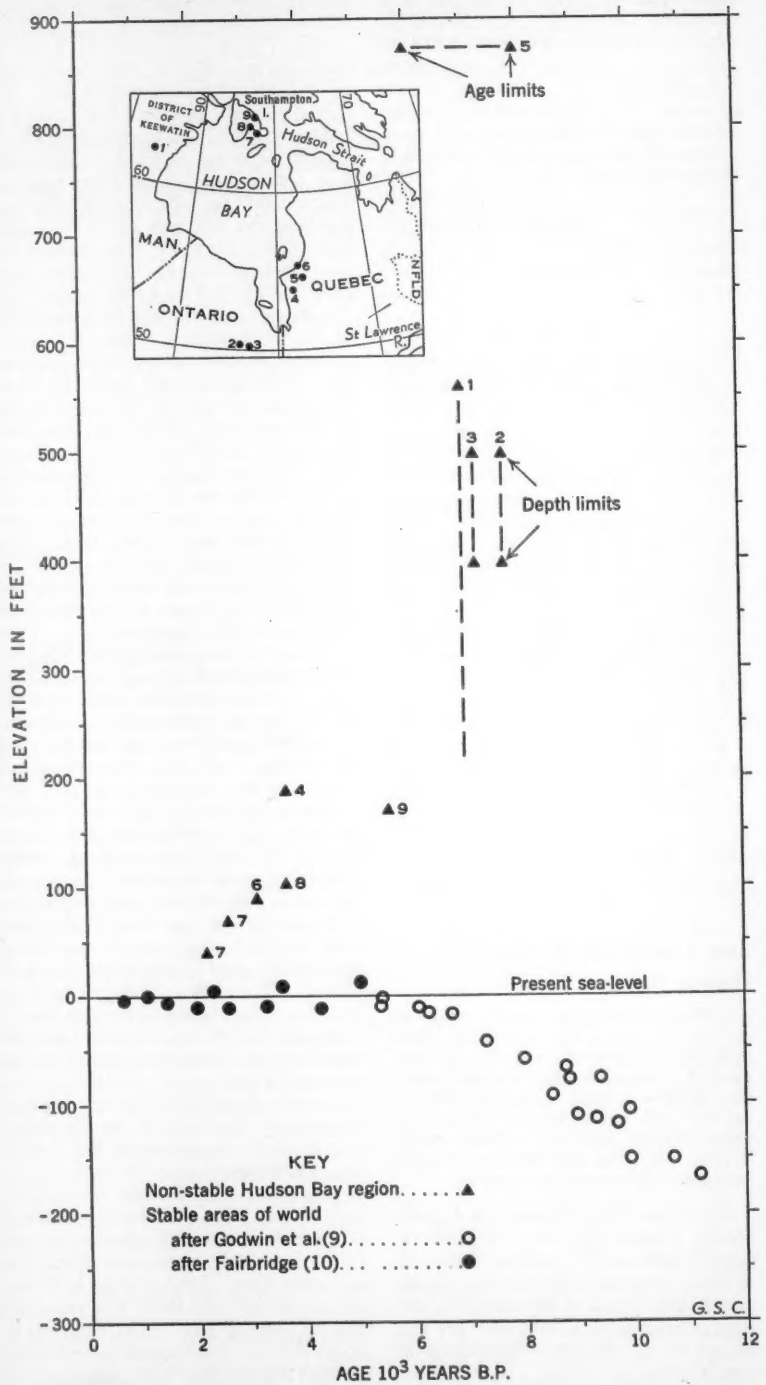

Fig. 1. Radiocarbon ages relative to elevations above and below present sea level (index map inset). Site 1, carbon dating index I (GSC) 8, shells (*4*). Site 2, I (GSC) 14, shells. Site 3, Gro. 1698, shells. Site 4, L433A, wood (*5*). Site 5, estimated age 6000 to 8000 yr. Site 6, L441A, wood (*5*). Site 7, P76, P77, burned bone (*2*). Site 8, S12, shells (*8*). Site 9, S13, shells (*8*). [Dating stations referred to above: I (GSC), Isotopes (Geological Survey of Canada); Gro., Groningen; L, Lamont; S, University of Saskatchewan; P, University of Pennsylvania.]

ized in Fig. 1, and a comparative curve is shown for changes of sea level through postglacial time in the stable areas of the world. The rate of emergence around Hudson Bay follows an exponential curve with an initial rapid uplift of the order of 20 feet per century, and later a much decreased rate of the order of 1 to 3 feet per century. The samples dated are not all equally reliable, for they are of different materials from many regions, and correlation of material to a stand of the sea cannot be precise. Hence, the graph gives only the relative rates of emergence.

The similarity of events around Hudson Bay is also recorded in a section through the soil strata. The composite section valid for either side of the bay has bedrock at the base, overlain by glacial till and sand, then by marine—usually fossiliferous—clay, silt, and sand, and then by beds of organic, alluvial, or dune deposits of peat and sand. Lake beds can be expected below the marine or glacial deposits south of Hudson Bay. In the Fort George–Great Whale region the many sections I examined (*5*) show thick beds of dark, odoriferous clay with shells, overlain by thick beds of stony silt with shells and wood, and with beds of alluvial sand overlying the silt. A bore hole at Fort George traversed 15 feet of alluvial sand, then 185 feet of the dark, odoriferous clay before encountering bedrock.

The marine submergence has been shown to mark a series of events around Hudson Bay. It is here proposed that the name "Tyrrell Sea" be given to that late glacial and postglacial sea in the Hudson Bay region, after the explorer and geologist Joseph Burr Tyrrell (1858–1957), who was one of the first, if not the first, to describe and map shore lines related to this submergence. This sea would include Hudson Bay and all the surrounding land that was submerged at the maximum extent of the postglacial marine submergence, in Quebec, Ontario, Manitoba, and Keewatin northward to and including Wager Bay and the islands of Southampton, Coats, and Mansel. The Tyrrell Sea reached its maximum expanse 7000 to 8000 years ago, and Hudson Bay is its modern remnant.

The features and events described for this region are remarkably similar to those described for the central zone of the maximum Scandinavian ice sheet, including rates of upwarping calculated by Niskanen (*11*) and washboard moraines reported by Hoppe (*12*) (*13*).

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15 February 1960

Colloidal Silica as a Standard for Measuring Absolute Fluorescence Yield

Abstract. The use of colloidal silica as a standard for fluorescence efficiency measurements is proposed. Its advantages over glycogen as a standard are availability, purity, and stability. Absolute fluorescence yields are reported for a number of substances and compared with values in the literature.

Most methods for determining the absolute quantum yield of fluorescence involve either evaluation of the absolute geometry of the apparatus or compensation for it by comparison with a standard scatterer. The latter is usually accomplished by comparing emission from fluorescent solutions with radiation scattered by a magnesium oxide plate, under conditions of identical geometry. Both relative-scattering methods and absolute-geometry methods are tedious and suffer from poor reproducibility (generally 20 percent relative).

Recently, Weber and Teale (*1*) published a novel method for determining absolute quantum yields of fluorescence. Their method was based on a comparison of the radiation emitted by fluorescent solutions with that scattered by a solution of macromolecules, attenuating the incident radiation to the same extent. The macromolecules behave as pure dipolar scatterers of the incident radiation, and after correction for polarization of the scattered radiation, are equivalent to a material of unit quantum efficiency. By comparison of fluorescent solutions with solutions of the standard scatterer, under identical conditions, the following equation can be derived for the quantum efficiency:

$$q = \frac{[\mathrm{d}F/\mathrm{d}E]_{\lambda_0}\,[3 + P_f]\,f(\lambda_0)}{[\mathrm{d}S/\mathrm{d}E]_{\lambda_0}\,[3 + P_s]\,f(\Delta\lambda)} \quad (1)$$

where $\mathrm{d}F/\mathrm{d}E$ is the slope of a plot of fluorescent intensity against absorbance for the compound under investigation, $\mathrm{d}S/\mathrm{d}E$ is the slope of a plot of intensity of scattered radiation against apparent absorbance for the standard scatterer, P_f is the polarization of fluorescence, P_s is the polarization of the scattered radiation, and $f(\lambda_0)/f(\Delta\lambda)$ is a correction factor for the difference in detector response to the wavelengths of the scattered radiation and the fluorescent radiation. Thus, the only experimental data necessary to determine fluorescence efficiency are plots of emission versus absorbance for the compound under investigation and the standard scattering material. By using an experimental apparatus not much different from a simple fluorometer, it was possible for Weber and Teale to obtain quantum yields reproducible to about 7 percent.

The standard scattering material used by Weber and Teale was an aqueous solution of glycogen. Although this material gave reproducible quantum yields, we felt that it was not generally desirable as a standard scatterer because of three inherent disadvantages: (i) the material is not readily available in pure form; (ii) since glycogen is naturally occurring, contamination by small amounts of impurities is possible; (iii) the solutions are not stable over a long period of time. The purpose of the present investigation was to find an acceptable substitute for glycogen that is readily available, free from possible contamination, and stable. After a survey of several possible materials, we chose a suspension of colloidal silica in water, sold under the trade name of Ludox (*2*). This material is completely satisfactory in terms of the above criteria, and it gives quantum yields reproducible to about 7 percent relative, agreeing with the values reported by Weber and Teale to within 0.02 quantum yield, on the average.

The apparatus used was essentially that of Weber and Teale with the following minor modifications. The source of radiation was an AH-6 mercury arc. The 3650 and 3130 line groups were isolated with filters as described by Kasha (*3*). The detector in all instances was an RCA 6217 photomultiplier tube, with an integrating screen of 10^{-3} *M* rhodamine B in ethylene glycol. A Heathkit "Multimeter" was used to measure the photocurrent.

Ludox, the radiation-scattering medium used for this work, is colloidal silica (light-scattering grade GC-3414-.85). The molecular weight of this material compared favorably with the molecular weight of the glycogen used by Weber and Teale (1 to 2×10^6 and 2 to 9×10^6, respectively). It had a uniform spherical particle size of 10 to 15 mμ (diameter). A plot of apparent absorbance against reciprocal fourth power of the wavelength gave a straight line.

Baker reagent-grade benzene and U.S.P. ethanol were used throughout. Phillips Petroleum research-grade hexane was used. The integrating screen used Allied Chemical and Dye XH-P grade ethylene glycol (synthetic and nonfluorescent).

Anthracene (Eastman Special Grade) gave a violet fluorescence and was used without further purification. Naphthalene (Eastman White-Label) was purified by distillation and subsequent recrystallization from alcohol. Fluorescein (Eastman Tech.) was acetylated and recrystallized from alcohol until it was colorless. Pure fluorescein was produced by saponification of the purified acetate. Eosin (Eastman Tech.) was purified in a manner similar to fluorescein except that the acetate was recrystallized from benzene. Acriflavin (National Aniline High-grade) was dissolved in bicarbonate solution and precipitated as the hydrobromide. DuPont technical Koch acid (1-naphthol-3,6,8-trisulfonic acid), sodium salt, was recrystallized four times from 10-percent sodium chloride solution.

Table 1. Comparison of quantum yield values.

Compound	Solvent	Quantum yield		
		This report	Weber and Teale	Other works
Acriflavin	Water	0.56	0.54	0.40 (*5*)
Anthracene	Benzene	0.31	0.29	0.24 (*6*)
Anthracene	Ethanol	0.30	0.30	
Naphthalene	Hexane	0.13	0.10	
Naphthalene	Ethanol	0.13	0.12	
Fluorescein	0.1 N NaOH	0.93	0.93	0.72 (*5*), 0.80 (*7*), 0.79 (*8*)
Eosin	0.1 N NaOH	0.20	0.19	0.15 (*7*)
Koch acid, sodium salt	Water	0.14	0.15	

Table 1 compares the quantum yields obtained in this study with those of Weber and Teale as well as with the results of other workers. The values obtained by using Ludox as a standard scatterer show agreement to within 0.02 quantum yield on the average. This corresponds to an average agreement of about 6 percent, the approximate uncertainty associated with a given result.

Generally, glycogen and/or Ludox give quantum yields somewhat higher than those obtained by other workers. The lower values of other workers probably can be traced to one of the following experimental difficulties: improper evaluation of the geometry of the system, materials of questionable purity, or measurements on solutions having too great a concentration (*4*).

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21 December 1959

On the Presumed Sterile Induction of Plant Tumors

Abstract. A cooperative reinvestigation of the possibility that filtrates of crown-gall bacterial cultures can induce autonomous tumors in plants has been conducted. The results indicate that the neoplasms formed after treatment do not fulfill the criteria for crown gall since they are not autonomous.

The isolation and characterization of the "tumor-inducing principle" involved in the transformation of normal plant cells into autonomous crown-gall tumor cells (*1*) is important to an understanding of the neoplastic alteration of plants. Klein (*2*) reported that tumor-inducing principle activity for tomato plants was found in filtrates of media containing plant sap in which crown-gall bacteria had grown. This report was confirmed by Manigault *et al.* (*3*) with geranium plants and was extended by Klein and Knupp (*4*) to disks of carrot phloem and by Bender and Brucker (*5*) to tomato, *Datura*, sunflower, and *Kalanchöe* plants.

On methodological and experimental grounds, the report of Klein (*2*) and, on conceptual grounds, the studies of Manigault *et al.* (*3*) were questioned by Braun and Stonier (*6*). Bopp, in a personal communication, reported inconclusive results in attempting to repeat the work of Manigault *et al.*, while Braun and Stonier obtained negative results in three rather large series of experiments. Thomas and Klein (*7*) reported positive results on carrot phloem disks with test solutions produced from precipitated and dialyzed culture media.

In view of the potential importance of the positive reports and the controversy which existed concerning the interpretation of those results, it was felt advisable to join in a cooperative investigation of the problem. This report covers the research conducted by us over a 6-month period, with full access to all available research notes and information.

The positive results on tomato reported by Klein (*2*) were obtained following passage of relatively large volumes of metabolite solutions (about 150 ml) through a single porcelain filter candle having a maximum pore diameter of 1.7 μ. It is clear from results obtained in the cooperative effort as well as from other types of information that this report must be rejected because of bacterial contamination of the test solutions. In this instance the methodological error involved testing too small an aliquot of the total filtrate for sterility. It was found, for example, that even when culture fluids were subjected to centrifugation for 25 minutes prior to filtration through a single candle, the filtrate contained small numbers of bacteria. Of 25 1-ml samples of filtrate tested in one experiment, two samples were contaminated with demonstrably virulent crown-gall bacteria. An equal number of samples of a filtrate obtained by passage through two filter candles of increasing fineness were, on the other hand, uncontaminated. In no instance was it possible to obtain tumors on tomato plants when sterile preparations were applied according to the method described by Klein (*2*).

Kalanchöe, tomato, and *Datura* plants, as well as the phloem tissue of carrot roots, were treated with purified test solutions prepared according to the methods of Thomas and Klein (*7*). There was no response when these preparations were introduced on three successive days into wounded stems of *Kalanchöe* plants. Within 48 to 72 hours after the start of the experiments, localized "swellings" were observed at the points of inoculation in tomato and *Datura*. These did not continue to enlarge beyond a week, a time limit which is characteristic of self-limiting growths resulting from localized areas of irritation.

Similar swellings were observed in tomato but not in *Datura* when wounded controls were treated at the cut stem end above the wound with 1-percent indole-3-butyric acid in lanolin. Wounded control plants showed typical healing responses. Intact plants treated with preparations from media in which avirulent bacteria had grown showed little or no response. On the other hand, tumors initiated by virulent bacteria were still actively growing and had reached massive size after a period of 5 weeks. Disks of carrot phloem tissue treated with these preparations formed small, raised overgrowths which were in no instance of the size or vigor of tumors induced by virulent bacteria. Because of the great variability in the responses of carrot disks treated with test preparations, several different test plants should be examined in such studies.

Since the preparations developed by Thomas and Klein with the use of carrot phloem as a test object did not induce the formation of autonomous neoplasms either on carrot phloem disks or when applied to stems of intact plants of three highly susceptible species, these preparations cannot, on the basis of evidence available, be considered to be the tumor-inducing principle. The concept that sterile induction of crown gall on carrot had been accomplished was derived primarily from etiological considerations in which the timing of the responses, the nature of the pre- and post-treatments, the virulence of the bacteria, and variations in the methods used to obtain active preparations were given paramount consideration. These criteria are not considered adequate for a demonstration of the sterile induction of a crown-gall tumor.

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4 February 1960

Negative Afterimage without Prior Positive Image

Abstract. A procedure is described which causes an observer to see a negative afterimage of a visual field without seeing the field itself. This phenomenon is shown to be closely related to ordinary afterimages and to temporal visual masking.

In order to observe negative afterimages reliably, it has usually been necessary that intense and/or prolonged stimulation of the eye by the stimulus object be followed by stimulation by a homogeneous grey or white field. This sequence of stimuli to the eye is usually arranged by voluntary eye movements. The negative afterimage appears against the white field in colors complementary to the stimulus and with brightness relations reversed. One exception to this procedure was described by Bidwell (*1*). Bidwell rotated a sectored disk in front of a red light. A typical presentation to the eye (repeated 6.25 times per second) consisted of (i) 80 msec of darkness, (ii) 20 msec of red light, and (iii) 60 msec of white field. Subjects reported the apparent color of the red light as cyan, the complement of red. Bidwell noted the similarity between the sequence of successive stimuli to the eye in observing afterimages by means of eye movements and the sequence in his procedure, namely, that a homogeneous, illuminated field immediately follows the stimulus. The difference is that, in the usual observation of negative afterimages, the sequence of images on the retina is controlled by relatively slow eye movements, whereas Bidwell used a mechanical control.

In the experiments reported here, a more flexible apparatus than Bidwell's rotating disk was used: a tachistoscope which permits the independent illumination of two optically superimposed fields. For example, if after a few seconds of dark adaptation, an observer is shown a card containing black letters on a white background (20 msec, 70 ft-lam) and this stimulus is followed immediately by a homogeneous white field (75 msec, 22 ft-lam) then he will report seeing bright *white* letters, clear and distinct, on a less white background. Similarly, a hand holding a (green) dollar bill appears as a pale green hand holding a pink bill, which demonstrates that the seen colors may conflict strongly with expectancy. Black and white as well as color photographic negatives look more like positives, and vice versa. If the presentation is recycled several times a second, a "continuous," color-reversed, flickering image is seen. Only by blinking in phase with the presentation, by strong squinting, or by sudden eye movements, all of which pervert the experimentally arranged sequence, is it possible to see the stimulus even briefly in its "natural" colors.

A simple prototype of the procedure described above for producing a continuing negative image was selected for quantitative study. A cycle time of 0.5 second was used because further increases in cycle time made little difference in results. From time 0.0 to time 75.0 msec of the cycle, a homogeneous 4×7 inch white field (masking field) was illuminated to a brightness of 46.5 ft-lam. The viewing distance was 40 inches. A 1-inch circle (test field), which was spatially superimposed on the masking field, was illuminated for less than 0.1 msec during each cycle. The energy of this test flash and its time of occurrence relative to the onset of the masking field (phase) were varied systematically.

Figure 1 shows the responses made by one observer to each stimulus presentation. Each point of Fig. 1 represents a particular stimulus presentation; all possible phases (−250 to +250 msec) are represented. The masking flash begins at time 0.0 and continues until time 75.0 msec. Thus, presentations in which the test flash precedes the masking flash are represented to the left of 0.0; presentations in which the test flash occurs during or after the masking flash are presented to the right of 0.0 msec.

The observer's responses fall naturally into two categories: those which indicate that he could see the test circle and those which indicate that the circle was not visible ("total masking" region of Fig. 1). The region of visibility may itself be further subdivided according to the appearance of the test field. Since the average energy density within the test circle is always greater than that of its surround, the test circle is usually seen as a light circle upon a darker surround. For some presentations, however, the observer reported that the test circle appeared to be darker than its surround. The limited range of phases and intensities for which this response was recorded are represented as the "reversal" region centered above 0.0 on Fig. 1. This "reversal" region indicates those stimulus presentations for which a negative image of the test field is seen without a prior positive image. For a closely related class of presentations ("ambiguous" regions, Fig. 1) the test field is seen as a circle of ambiguous

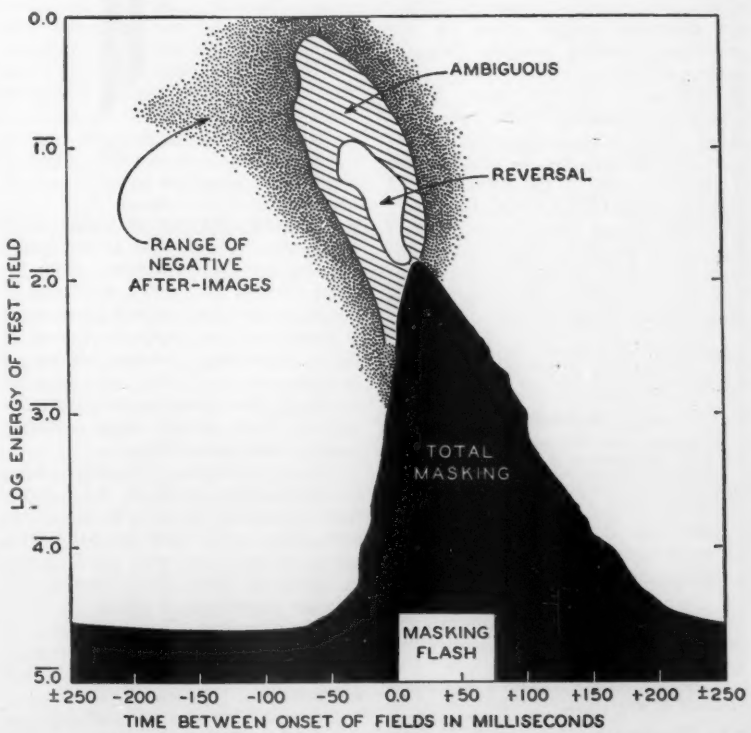

Fig. 1. Interactions between a small circular test patch and the masking field upon which it is geometrically superimposed. The test patch is flashed for 0.1 msec, and the masking field is flashed for 75.0 msec, beginning at time 0.0. As the energy in the test patch and its temporal occurrence relative to the masking field are varied, the reported appearance of the test patch may be a positive image, a negative image, an ambiguous image, or it may be masked completely.

brightness. In rapid succession it usually appears both darker and lighter than its surround. In all regions except the "masking," "reversal," and "ambiguous" regions the circle is seen as "positive," that is, as lighter than its surround. The subject was required to report on the presence of (subjective) afterimages as well as on the appearance of the test field itself. The stippled area of Fig. 1 represents the phases and energies of the test field for which reports of negative afterimages (of a prior positive image) were obtained.

The data of Fig. 1 confirm the qualitative statement that negative afterimages of a stimulus are seen when it precedes a homogeneous field. However, Fig. 1 shows much more. It demonstrates that good quantification is possible even of such an evanescent phenomenon as a negative image. The general topological properties of Fig. 1 remain unchanged for the many other kinds of visual stimuli that we have tried, including stimuli of different sizes, shapes, colors, and so forth. If the data are represented as in Fig. 1, then the area of "reversal" is contained within the area of "ambiguity" which, in turn, is contained within the area of "negative afterimages." Thus, areas of relatively more prominent negative images are contained within areas of less prominent negative images. This *invariant relation of containment* between the degrees of negative images constitutes strong evidence for their common origin. The particular negative images seen by Bidwell are a special case ("reversal" area) of the more general negative image phenomenon. The reversal conditions are simultaneously favorable for the negative afterimage and unfavorable for the positive image; therefore, only a negative afterimage and no prior positive image is seen.

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18 February 1960

A Simple Inexpensive Potometer

Abstract. A simple, inexpensive potometer, suitable for student use, is described. It differs from the conventional type mainly in that it does not contain a funnel and stopcock arrangement.

The conventional potometer, described in most textbooks of plant physiology (*1*), has become a widely used tool for the demonstration and measurement of transpiration. Although the apparatus really records the rate of water uptake, the rates of water uptake and water loss (due to transpiration) are, for practical purposes, often the same. Despite the limited usefulness of the potometer for research purposes, it is widely used in laboratory courses of plant physiology, mainly because it provides a rapid and very graphic means of illustrating and measuring the rate of water uptake under different environmental conditions.

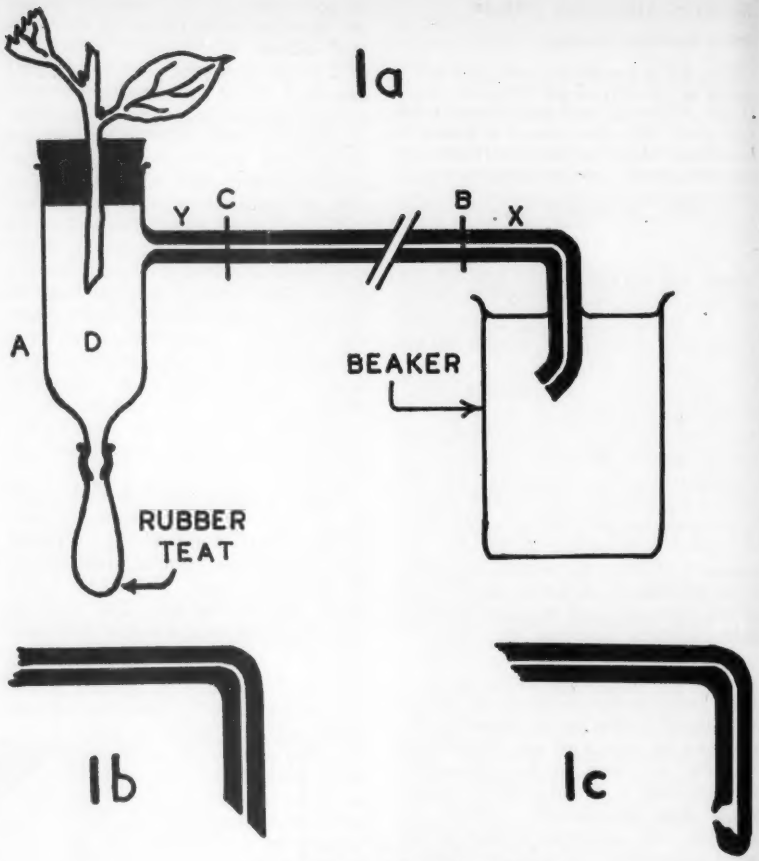

Fig. 1. The modified potometer.

In my experience with large classes of undergraduate students, it has rarely been possible to make wide use of the conventional potometer because of the cost of these potometers, the high rate of breakage, and the difficulty that students encounter in trying to lubricate the stopcocks. Clogged, leaking, or "stuck" stopcocks are all too commonly the cause of faulty results and broken potometers.

By modifying the conventional potometer, mainly by eliminating the funnel and stopcock arrangement, a potometer has been developed which is inexpensive and robust and which has proved to be accurate and very suitable for student use.

The potometer (Fig. 1*a*) is set up in the usual way and is clamped to a retort stand at position *A*. Special care must be taken to make sure that the rubber teat is free of air bubbles. By lowering the beaker temporarily, an air bubble is drawn into the capillary tube. For a particular run, the air bubble is given time to travel a certain fixed distance (*B* to *C*) along the horizontal part of the capillary tube.

To prepare the apparatus for a second run, the air bubble is completely expelled from the capillary tube before it reaches the container *D*, by gently squeezing the rubber teat. The apparatus is refilled with water by gently releasing the pressure on the rubber teat.

As will be noted, the procedure with this apparatus differs from that with the conventional potometer in that (i) the apparatus is refilled with water from the beaker instead of with water from a funnel and stopcock arrangement attached to the capillary tube at *Y* in the conventional apparatus; and (ii) a fresh bubble must be collected before each run, whereas with the conventional apparatus, the same bubble is used in

all determinations (the bubble is repeatedly displaced to point *X* in the capillary tube).

Because the air bubble has to be expelled completely from the capillary tube, it is important that the tip of the capillary tube be made as illustrated in Fig. 1*a* or 1*b* and not as commonly constructed in conventional potometers (see Fig. 1*c*); in the latter case the capillary tube is first sealed off, and a lateral aperture is blown out.

The air bubble need not be completely expelled from the capillary tube before each determination; the original bubble can be displaced to the starting point several times by merely tightening a screw clamp which can be attached to the rubber teat.

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7 December 1959

Effect of DDT on Free Amino Acids of Susceptible and DDT-Resistant Aedes aegypti Larvae

Abstract. The exposure of mosquito larvae (*Aedes aegypti* L.) to LC_{50} concentrations of DDT for various periods of time resulted in a selective increase in the alanine level of a DDT-resistant strain after 4 to 8 hours' contact with the insecticide, whereas the concentration of this amino acid in a susceptible strain remained comparatively low.

Evidence that DDT may disturb amino acid metabolism in insects has been presented by Reiff (*1*) who found that this insecticide reduced the amino acid level of the hemolymph of DDT-susceptible house flies, and by Corrigan and Kearns (*2*) who reported that DDT characteristically lowered the proline content of the hemolymph of *Periplaneta*. Previous investigations in our own laboratory have demonstrated that when larvae of a susceptible strain and a DDT-resistant strain of *Aedes aegypti* were exposed to DDT, the total free amino acid content of the resistant strain increased while that of the susceptible strain remained essentially the same (*3*). The present report is concerned with the continuation of this work to determine which amino acids are particularly affected by DDT.

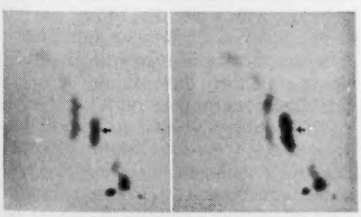

Fig. 1. Two-dimensional chromatograms of the DDT-treated Trinidad larvae (right) and the untreated controls (left) showing a marked increase in the alanine level (spot at arrow) upon 4 hours' exposure to DDT.

Third and fourth-stage larvae of a susceptible strain (UTMB) and a DDT-resistant strain (Trinidad) were exposed to their respective LC_{50} concentrations of DDT (0.5 and 2.5 parts per million after 24 hours' exposure) for periods of 2, 4, 8, and 16 hours, respectively. In preparation for each experiment, approximately 1000 larvae of each strain were rinsed thoroughly in distilled water and divided equally into each of two enameled pans containing 400 ml of distilled water. The appropriate quantity of an acetone solution of DDT (p, p' isomer) was added to one pan prior to introduction of the larvae, the other pan serving as the control. At the end of the exposure period the larvae, all of which were still living, were removed from their respective containers by means of separate strainers. They were then rinsed in two changes of distilled water, weighed, and homogenized in acetone, with a tissue grinder. After centrifugation, measured amounts of the supernatants were applied to sheets of Whatman 3-mm filter paper and chromatographed by previously described techniques (*4*). Chromatograms of the test and control extracts were first compared visually for evidence of differences in concentration of amino acids. Densitometric measurements were then made of the various ninhydrin-positive spots appearing on two-dimensional chromatograms. The results presented here represent the combined data from five separate sets of tests conducted on different generations of larvae at each exposure period.

Virtually complete reproducibility was obtained between tests. The only striking difference in amino acid levels between the UTMB and Trinidad strains after exposure of the larvae to DDT was in the concentration of alanine, which was greater in the latter strain (Fig. 1). The maximum density values for this amino acid on chromatograms prepared after 2, 4, 8, and 16 hours of DDT exposure were 85.5, 93, 92.5, and 80, respectively, for the Trinidad strain, a peak occurring during the 4- to 8-hour period. The alanine level of the susceptible strain increased somewhat after 4 hours' exposure to DDT and declined sharply thereafter, the corresponding density values being 84, 87.5, 85, and 78 (Fig. 2). Interestingly enough, the alanine content of the corresponding untreated and unfed controls also rose during the 2- to 4-hour period. Whereas the level of this amino acid was somewhat higher in the UTMB strain at 2 hours, the reverse was true after 8 hours. Strain differences in the concentration of several other amino acids were of extremely small magnitude, and were not consistent.

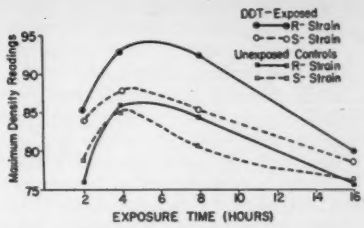

Fig. 2. Maximum density curves showing the alanine concentration in the susceptible (*S*) and DDT-resistant (*R*) strains of larvae and their corresponding controls after 2, 4, 8, and 16 hours' exposure to DDT.

As yet, it is not known whether the increase in alanine content which follows DDT exposure is due to an increased rate of alanine synthesis or a decreased rate of metabolism. The similarity in shape of the density curves representing the DDT-treated larvae and the untreated controls suggests that the effects of DDT on alanine metabolism are of a quantitative nature. In any case, the DDT-resistant strain exhibits either greater alanine production or is less able to utilize it than is the normal strain. The finding that *Aedes aegypti* larvae are capable of synthesizing large quantities of alanine (*5*) is consistent with the possibility that the differences noted between the two strains used in this study may be a reflection of the comparative activity of transaminases or other enzymes.

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6. This study was supported by a research grant from the Robert A. Welch Foundation.

7 April 1960

Association Affairs

Preliminary Announcement of the New York Meeting and Call for Papers by AAAS Sections

In the 112 years of its existence the American Association for the Advancement of Science has followed the intentions of its founders by holding the annual meeting in a wide variety of cities in the United States and Canada. This year's 127th meeting, 26–31 December, will be the eighth annual meeting to be held in the nation's largest city. Only four cities (Boston, Philadelphia, Washington, and Chicago) have been host as many as seven times. This will be the first occasion on which it has been possible for the AAAS to meet in New York's Grand Central zone.

Those who have attended recent AAAS meetings—notably in Washington in 1958 and last December in Chicago—need not be reminded that no other scientific meeting presents such a variety of important and attractive symposia in all major fields of science or affords such opportunities for interdisciplinary programs and special events of general interest. Those who have not been to an AAAS meeting for some years may not realize what continuing growth there has been in the attendance—a reflection of the ever-increasing attractiveness of the programs.

Every New York meeting of the AAAS has been well attended, but there are factors that make it virtually certain that the previous New York meeting's registration total of 5327 will be exceeded this year by 1000 or more. These are, the nature and number of the participating societies; the increasing scientific population of the New York area; the improved pattern of the meeting, which tends to prevent too heavy a concentration of events on any one day; and, most of all, the care and thought that have already been devoted to the selection of topics and speakers for the symposia and special events. The attractiveness of this year's programs will make the eighth New York meeting a particularly large and memorable scientific congress.

Despite its size, however, the meeting will be convenient, comfortable, and comparatively inexpensive. The five large hotels which will house the approximately 300 sessions—the Commodore, Biltmore, Roosevelt, Belmont Plaza, and Waldorf-Astoria—are clustered around Grand Central Station on East 42nd Street. All have good-sized and comfortably furnished lobbies and session rooms. The special flat rates for sleeping rooms—single, $8.50, double with double bed, $14, and double with twin beds, $15.50 in the first four hotels and $10, $16, and $18 respectively, in the Waldorf—are almost unprecedentedly low. Those interested in combining a winter vacation trip with the meeting will find the theatre district, Fifth Avenue shops, Rockefeller Center, the United Nations, and a variety of museums within easy walking distance of the Grand Central zone. In the expectation that a considerable number of wives will accompany their husbands, there will be a Committee on Women's Events.

All 18 sections and many participating societies have arranged sessions both for the specialist and for those concerned with general developments in science. Thus, there will be programs, events, and features of interest to all. As the major portion of this announcement makes clear, the officers of the sections and the other program chairmen are working early and hard to emulate their past achievements.

Among the societies holding their national meetings with the AAAS are the following: American Astronomical Society, American Nature Study Society, American Society of Zoologists, History of Science Society, National Association of Biology Teachers, Scientific Research Society of America, Sigma Delta Epsilon, Society for General Systems Research, Society for the Study of Evolution, Society for the History of Technology, Society of Systematic Zoology, and Society of the Sigma Xi.

Among other societies with special or regional programs of several days' duration are the following: American Association of Clinical Chemists, American Astronautical Society, American Geophysical Union, American Meteorological Society, American Physiological Society, American Psychiatric Association, American Society of Criminology, Association of American Geographers, Ecological Society of America, National Science Teachers Association, and Torrey Botanical Club.

Still other organizations will have important conferences or programs—for example, the New York Academy of Sciences, the Institute of Management Sciences, American Economic Association, American Sociological Association, American Statistical Association, American Political Science Association, Society for Industrial and Applied Mathematics, and the American Council on Women in Science.

Special Sessions

The Committee on AAAS Meetings, which has responsibility for the general pattern of the meeting and the details of the two general sessions, on "Moving Frontiers of Science," in a joint meeting with the secretaries of the AAAS Sections, early this year, outlined a particularly attractive series of general events. In chronological order, these are as follows.

26 December, evening. Part I of the AAAS General Symposium on "Moving Frontiers of Science." This program, which consists of lectures by authorities in their respective fields, is planned to be of general interest to the entire attendance and to include recent developments in terms intelligible to scientists in other disciplines. All of the sections and many of the participating societies have left these times open in their schedules.

One of the lectures on this first evening of the meeting will be "Recent work on meteorites," by Edward Anders, department of geological sciences, California Institute of Technology, whose shorter paper on meteorites, presented before a joint session of Section D–Astronomy and the American Astronautical Society at the Chicago meeting, received the 1959 Newcomb Cleveland Prize.

27 December, evening. A special program on the critical challenge to scientists of the conditions—social, political, and moral—that exist in the world today. Sir Charles P. Snow, internationally known scientist, writer, and lecturer, will state the major aspects of the current challenge, and several scientists of prominence will give their views on how they think scientists should respond to these great problems.

28 December, morning. Three interdisciplinary symposia in the physical, biological, and social sciences, presented concurrently: "Plasma: Fourth State of Matter," jointly sponsored by sections B–Physics and D–Astronomy and by the American Astronomical Society (Stanley S. Ballard, University of Florida); "Life under Extreme Conditions" (Karl M. Wilbur, Duke University), the more general portion of

the symposium of section F–Zoological Sciences on the same subject; "Urban Development and Renewal" (Frank C. Whitmore, Jr., U.S. Geological Survey, and Firman E. Bear, Rutgers University), a broader part of the symposium of section O–Agriculture on "Rural Land Use," cosponsored by sections E–Geology and Geography and K–Social and Economic Sciences and by a number of appropriate societies.

28 December, afternoon. Part II of "Moving Frontiers of Science." There will be two lectures, one of which will be "The molecular basis of vision," by George Wald, Biological Laboratories, Harvard University.

28 December, evening. The AAAS retiring presidential address, by Paul E. Klopsteg, and a reception for all registrants.

29 December, evening. Honor Societies Night. The annual joint address of the Society of the Sigma Xi and the United Chapters of Phi Beta Kappa and the second annual address of the Tau Beta Pi Association with the AAAS probably will be given concurrently. The AAAS Smoker for all registrants will follow.

30 December, evening. The annual illustrated lecture and film of the National Geographic Society, usually a first showing.

Other General Events

The AAAS Committee on Science in the Promotion of Human Welfare (Barry Commoner, Washington University, St. Louis) plans a series of important sessions: (i) A one-session symposium on "Science in the 1960 Elections"; (ii) open hearings, 4 to 6 P.M. on three days, with selected papers on "What are scientists' responsibilities in the promotion of human welfare?" (prior to the meeting AAAS members and other scientists will be invited to submit one-page abstracts from which the Committee will select the papers to be read and discussed); and (iii) a conference on "Public Education on Radiation Problems."

The program of the AAAS Cooperative Committee on the Teaching of Science and Mathematics (John R. Mayor, AAAS) will be (i) separate sessions on "Progress in Teacher Certification in Science," which will include a report on the NASDTEC-AAAS Teacher Preparation-Certification Study and references to the Garrett report, as published in *Science* in April, and (ii) a symposium, "Science in the Elementary School" (three or four papers), in which the problems of teaching science in the elementary school will be analyzed and in which there will be reports from current curriculum studies in the area, such as the study at the University of California under the direction of Robert Karplus, department of physics.

The ninth annual Conference on Scientific Communication (George L. Seielstad, Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Md.) this year will be devoted largely —or more probably, entirely—to a multisession symposium, "The Sciences in Communist China," an objective, factual appraisal as complete as circumstances permit. The speakers will be competent scientists in their respective fields who will have studied the literature in Chinese and in translation. It is anticipated that some speakers will have traveled in Communist China and thus will have a first-hand familiarity with research there. This program, the responsibility of the AAAS as a whole, will be cosponsored by the National Science Foundation and by ten organizations—American Chemical Society, American Geological Institute, American Geophysical Union, American Institute of Biological Sciences, American Institute of Physics, American Mathematical Society, American Meteorological Society, Engineers Joint Council, Federation of American Societies for Experimental Biology, and Social Science Research Council—whose official representatives constitute the planning committee.

The program of the tenth annual Conference on Scientific Manpower (Thomas J. Mills, National Science Foundation), cosponsored by the National Science Foundation, National Research Council, Engineering Manpower Commission, Scientific Manpower Commission, and Section M–Engineering, though not completely formulated, is expected to include papers in the area of science teaching and science teachers and possible cooperation with the Junior Scientists Assembly.

The Academy Conference, founded in 1927 and composed of the official representatives of the now 46 academies of science affiliated with the AAAS, has had a program at each annual meeting of the Association since the fifth New York meeting of December 1928. At this year's meeting of the conference, the 32nd, following a session on junior academies (the afternoon of 26 December), there will be a full day of sessions, 27 December. In the business meeting in the morning, an innovation will be the distribution (rather than the reading) of reports of the individual academies; thus more time will be provided for individual comments and for a general discussion of academy problems. In the afternoon, a symposium on National Science Foundation grants to the academies will be particularly valuable. The day will conclude with the annual Academy Conference Dinner and the conference presidential address by John G. Arnold, Jr. (Loyola University, New Orleans).

The third annual conference of the American Council on Women in Science, held jointly with Sigma Delta Epsilon, will have a major speaker, one panel ("Changing Educational Trends") coordinated by Father John Cortelyou, and a second panel ("Changing Cultural Attitudes") coordinated by Margaret Mead.

The AAAS Council will hold at least two sessions, on 27 and 30 December. Because election of the AAAS president-elect and of new members of the Board of Directors is now conducted by mail, more time is available at these sessions for consideration of matters that affect all science and society. The work of the Council is materially assisted by the Committee on Council Agenda and Resolutions and the Committee on Council Activities and Organization. Other committees and many of the sections will have business meetings.

Science Exhibits

The significance of the eighth New York meeting has already been recognized by those who produce the books, instruments, and materials which scientists and teachers use. Applications for exhibit booths on the ballroom floor of the Biltmore are being received at a most gratifying rate. At this time, seven months in advance of the meeting, only a few booths remain to be assigned.

The 1960 Annual Exposition of Science and Industry will be one of the most balanced and attractive ever staged. In the 103 booths available, leading publishers, optical companies, instrument makers, and many suppliers of laboratory materials and equipment will show their latest publications and products. In addition, there will be selected displays of some of the research activities of large industrial firms. The exposition alone would justify a trip to New York, and it is hoped that every registrant will budget his time so that he can visit the exhibits.

Incidentally, the exposition is *not* intended for young people below the college, or the exceptional high-school senior, level, for most of the exhibits would be too technical for younger students of science. (To meet the interests of the latter, the Association's Academy Conference annually arranges a Junior Scientists Assembly, at which eminent scientists address a large audience of high-school students on aspects of science and scientific careers.) In the best interests of both exhibitors and those interested in their displays, ***only registrants will be admitted to the exposition.***

The AAAS Science Theatre again will show a choice selection of science films, foreign and domestic, in a special room within the exposition area. Some have suggested that the theatre be expanded into a major attraction, but it has not seemed desirable to do this and, in a sense, compete with program sessions. As usual, the theatre will run each film at least twice. Those who are especially interested in a particular film thus will have more than one opportunity to see it.

Physical Facilities

For the AAAS as a whole, there will be coheadquarters hotels. The Commodore (2000 rooms, at 42nd Street between Grand Central Station and Lexington Avenue), with its capacious ballroom, will accommodate the large evening events, the AAAS business sessions, and the AAAS Pressroom. The Biltmore (1000 rooms, 43rd Street and Vanderbilt Avenue) will house the AAAS Office, the Visible Directory of Registrants, the Annual Exposition of Science and Industry, and the AAAS Science Theatre. Both hotels—one and one-half blocks apart, on two sides of Grand Central Station (they can be reached by underground passages *through* the station)—will have AAAS Main Registration-Information Center facilities.

Three other hotels will be the headquarters of related sections and societies—the Roosevelt (1100 rooms, 44th Street and Vanderbilt Avenue); the Belmont Plaza (800 rooms, 49th Street and Lexington Avenue); and the Waldorf-Astoria (2200 rooms, 49th Street and Park Avenue).

The headquarters of the sections and societies will be announced in *Science* in July, at which time coupons for housing and advance registration will appear among the advertising pages. (To secure the special flat rates, the hotel room coupon, or a reasonably accurate copy of it, should be used and sent directly to the AAAS Housing Bureau, 90 East 42nd Street.) As usual, advance registrants will receive the General Program early in December, by first-class mail. With all five hotels so close to each other, the meeting will be a particularly convenient one.

Programs. A synopsis of the programs, arranged by disciplines, follows. The names given in parentheses are those of section and society officers or program chairmen.

Mathematics (A)

The program of Section A (C. C. MacDuffee, University of Wisconsin) will begin on 26 December with the vice-presidential address of William L. Duren, Jr. (University of Virginia); a second, deferred vice-presidential address will be given by Gustav A. Hedlund (Yale University). Section A will sponsor a symposium on some problems in mathematical education (27 Dec.) and will cosponsor the symposium of the *Society for Industrial and Applied Mathematics* (Brockway McMillan, Bell Telephone Laboratories, Whippany, N.J.) (28 Dec.).

The Association for Computing Machinery (W. F. Cahill, National Aeronautics and Space Administration, Silver Spring, Md.) is arranging a session (29 Dec.) of invited papers on computing machines, which Section A will also cosponsor.

Physics (B)

Section B (Stanley S. Ballard, University of Florida), with Section D and the American Astronomical Society, will jointly sponsor the symposium on "Plasma: The Fourth State of Matter" (28 Dec.) mentioned above under General Events. In association with Section M–Engineering, a panel discussion is being planned on the place of nuclear engineering in the university curriculum. The annual physicists' luncheon will be cosponsored by Section B and Sigma Pi Sigma. The address following the luncheon will be given by retiring vice president Frederick Seitz (University of Illinois).

The American Astronautical Society will hold its first Annual Eastern Regional Meeting, with the New York Section (Ross Fleisig, 58 Kilburn Road, Garden City, N.Y.) as host. The program will include a two-session symposium, "Lunar Exploration," and a panel discussion on bioastronautics on 27 December and a second symposium, "Astro-Vehicle Systems Development," on 28 December. The society will cosponsor the "Space Physiology IV" symposium of the American Physiological Society.

The American Meteorological Society (Kenneth Spengler, AMS) will have a joint program with the National Science Teachers Association on the teaching of meteorology in secondary schools and papers on the significance of the data collected by the Tiros satellite. The society will also cosponsor appropriate sessions.

Chemistry (C)

The program of Section C (S. L. Meisel, Socony Mobil Oil Company, Paulsboro, N.J.) begins 26 December with sessions for submitted papers. Symposia on successive days are as follows: 27 December, two sessions, biochemistry and organic chemistry symposium: "Mechanism of Action of Antitumor Agents" (C. C. Price, University of Pennsylvania); 29 December, two sessions, organic chemistry symposium: "Recent Advances in the Chemistry of Macromolecules" (C. G. Overberger, Polytechnic Institute of Brooklyn); concurrent in the afternoon, inorganic chemistry symposium: "Chemistry of Synthetic Zeolites" (G. T. Kerr, Central Research Division, Socony Mobil Oil Company); 30 December, inorganic chemistry symposium: "New Developments in Coordination Chemistry" (J. C. Bailar, Jr., University of Illinois).

A chemists' dinner will be held the evening of 27 December. It is possible that the New York section of the *American Chemical Society* will cosponsor the entire program of Section C, as the Chicago section of the society did at the Chicago meeting in 1959.

The American Association of Clinical Chemists (Harry Goldenberg, Hillside Hospital, Glen Oaks, N.Y.) will have a symposium on a topic of current interest, sessions for contributed papers, and a dinner with a speaker.

Astronomy (D)

Section D (Frank Bradshaw Wood, University of Pennsylvania) will cosponsor all sessions of the American Astronomical Society and Section B's symposium on plasma. The vice-presidential address will be given by Ira S. Bowen (Mt. Wilson and Palomar Observatory), with N. U. Mayall (Lick Observatory) presiding.

The national meeting of the *American Astronomical Society* (J. Allen Hynek, Smithsonian Astrophysical Observatory, Cambridge, Mass.) will begin with a council meeting the afternoon of 28 December and continue through the morning of 31 December. It is anticipated that the Society's sessions, all in one hotel, will include three or more sessions for contributed papers, a symposium, the astronomers' dinner, and, probably, an address by a distinguished lecturer. Special joint AAAS-AAS convention badges will be used.

The *Astronomical League* (Chandler H. Holton, 833 Drewry Street, N.E., Atlanta, Ga.) is arranging a session which may be held early in the meeting period.

Geology and Geography (E)

The program of Section E (Frank C. Whitmore, Jr., U.S. Geological Survey) (27–30 Dec.) includes three two-session symposia, on different aspects of geology, and cosponsorship of other programs, notably part of the symposium of Section O on urban renewal (28 Dec.) and the program of the Association of American Geographers. At the annual Section E smoker (27 Dec.) the vice-presidential address will be delivered by Howard A. Meyerhoff (Scientific Manpower Commission). All geological sessions will be cosponsored by the *Geological Society of America.*

The *Association of American Geographers, New York-New Jersey Di-*

vision (Charles Morrison, Jr., American Geographical Society) will sponsor one or more sessions for contributed papers in geography (27 Dec.) and arrange a symposium, cosponsored by Section E.

The *National Speleological Society* (Brother G. Nicholas, University of Notre Dame) will have two symposia (27 Dec.), one on cave biology, the other on cave mineralogy (William B. White, Pennsylvania State University). The *National Geographic Society* will present its usual outstanding lecture and accompanying film on 30 December.

Zoological Sciences (F)

The program of Section F (Karl M. Wilbur, Duke University) will be coordinated with the national meetings of the American Society of Zoologists and the Society of Systematic Zoology. The two-session symposium, "Unsolved Problems in Biology V," will be joint with Section G and cosponsored by appropriate biological societies. The first two or three sessions of a second symposium, "Life Under Extreme Conditions," which will be specialized in nature, will precede the more general, interdisciplinary, final session on 28 December, already mentioned under General Events. Part 1, on cells, tissues, and microorganisms, will be arranged by A. Cecil Taylor (Rockefeller Institute), and part 2, on man, will be arranged by John P. Marbarger (Aeromedical and Physical Environment Laboratory, University of Illinois).

The vice-presidential address, by Viktor Hamburger (Washington University), is tentatively scheduled for the zoologists' dinner, held jointly with the zoological societies (probably 30 Dec.). The section's business meeting will immediately follow that of the American Society of Zoologists.

The program of the national meeting of the *American Society of Zoologists* (Ray L. Watterson, Northwestern University), with more than 20 sessions (27–30 Dec.) includes 11 or more sessions for contributed papers throughout the meeting period and a series of symposia, as follows: "Physiology of Molluscs" (Division of Comparative Physiology) and "Evolution of Vertebrate Feeding Mechanism" (Division of Vertebrate Morphology) concurrently, and "Evolution of Sex"—the genetics, cytogenetics, embryology, and endocrinology of sex determination—arranged by Emil Witschi (State University of Iowa) (28 Dec.). The four-session symposium, "Spermatazoön Motility" (David Bishop, Carnegie Institution of Washington, Baltimore), cosponsored by Section F, will be held 29 and 30 December; a two-session symposium, "Teaching of Animal Behavior" (Division of Animal Behavior), will be held jointly with the Ecological Society of America (30 Dec.). A panel discussion on research training facilities, under the auspices of the ASZ Education Committee, will be held on one of the last two evenings of the meeting. The zoologists' dinner probably will be held 30 December. The annual business meeting and election of officers of the society is scheduled for 29 December.

The *Society of Systematic Zoology* (Charles F. Lytle, Indiana University) will hold its 12th annual meeting with the AAAS. Key events will be a symposium featuring a series of anecdotal sketches of famous zoologists, arranged by a committee headed by Carl L. Hubbs (Scripps Institution of Oceanography) (27 Dec.) and a panel discussion of the forthcoming edition of the *International Code of Zoological Nomenclature*, led by W. I. Follett (California Academy of Sciences) (29 Dec.). The program will also include sessions for contributed papers, meetings of the council, the annual business meeting, social events for members and their guests, and a field trip to the American Museum of Natural History. The annual SSZ Library and Book Lounge for all zoologists will be open 27–30 December.

Biological Sciences (FG)

As a major part of its annual national meeting, the *American Society of Naturalists* (Reed C. Rollins, Gray Herbarium, Harvard University) will sponsor a two-session symposium, "Modern Trends in Population Biology," cosponsored by the Society for the Study of Evolution, the Ecological Society of America, and the American Society of Zoologists (27 Dec.). The symposium will include the presidential address of Leslie C. Dunn (Columbia University). The business meeting of the society will be held at the end of the morning session.

Beta Beta Beta Biological Society (Mrs. Frank G. Brooks, Box 515, Ansonia Station, New York 23, N.Y.), which meets biennially with the AAAS, will hold an interim meeting of the policy committee, two sessions, and a luncheon (27 Dec.).

The program of the *Ecological Society of America* (Richard S. Miller, University of Saskatchewan) will consist of sessions for contributed papers on plant ecology, animal ecology, and general ecology, and two or more symposia arranged by members of the society (26 and 27 Dec.); the two-session symposium, "Teaching of Animal Behavior," sponsored by the Section on Animal Behavior and Sociobiology, to be held jointly with the American Society of Zoologists and the National Association of Biology Teachers (30 Dec.), arranged by E. B. Hale (Pennsylvania State University). The Society will also cosponsor appropriate programs, including the symposium "Modern Trends in Population Biology," sponsored by the American Society of Naturalists; and the Human Ecologists' luncheon (27 Dec.).

The *Mountain Lake Biological Station* (Horton H. Hobbs, Jr., University of Virginia) again will sponsor an annual breakfast with the AAAS for all persons who have been students, investigators, or staff members, at the station since its founding in 1929. Probably it will be held 28 December and in the hotel where the biological societies will be based.

The annual national meeting of the *National Association of Biology Teachers* (Paul V. Webster, Bryan City Schools, Bryan, Ohio) will begin with business meetings on 26 December. During the meeting period there will be a joint meeting (27 Dec.) with the American Nature Study Society, the National Association for Research in Science Teaching, and the National Science Teachers Association; the annual NABT presidential address and luncheon (28 Dec.); and a series of separate sessions (27, 29, and 30 Dec.).

As in Chicago, the *Nature Conservancy* will hold a meeting of its National Committee for Natural Areas for Schools; arrangements will be made by John W. Brainerd (Springfield College, Springfield, Mass.).

The national meeting of the *Society for the Study of Evolution* (H. H. Ross, Illinois Natural History Survey, Urbana) begins 27 December with the two-session symposium "Modern Trends in Population Ecology," arranged by the American Society of Naturalists. On the morning of 28 December there will be concurrent symposia, "Phylogenetic Aspects of Evolution" and "Genetic and Biochemical Aspects of Evolution," presented by sections A and B, respectively. The general meeting of the society—business session and invited papers, with Alfred E. Emerson (University of Chicago) presiding—will be held the morning of 29 December. On the afternoon of 28 December, sections C and D, respectively, will sponsor concurrent symposia, "Speciation and Variation" and "Ecological Aspects and Methods."

The *Society of General Physiologists* (James W. Green, Rutgers University) is considering presentation of one or more groups of invited papers.

Botanical Sciences (G)

In addition to the two-session symposium, "Unsolved Problems in Biology V," to be held jointly with Section F, Section G (Barry Commoner, Washington University) will have a symposium, "Machine Methods in Biology," arranged by David Rogers (New York Botanical Garden), cosponsored by Section F and a number of biological

societies, including the *Botanical Society of America*. This program will be supplemented by a tour of the IBM offices. There will be sessions for contributed papers in the principal fields of botany, probably held jointly with the Torrey Botanical Club. The vice-presidential address of the section, by Barry Commoner, will be given at the joint botanists' dinner of Section G and all participating botanical societies.

The *Torrey Botantical Club* (C. A. Berger, Fordham University) is planning a luncheon, a series of talks, and exhibits.

Anthropology (H)

The program of Section H (Eleanor Leacock, City College, New York) will consist of the vice-presidential address of Cornelius Osgood (Yale University) (27 Dec.); a group of invited papers on the development of new nations, arranged by Elliott Skinner (New York University) (27 Dec.); sessions for contributed papers (28 and 30 Dec.); a two-session symposium, "Anthropological Theory," arranged by Solon Kimball (Columbia University) (29 Dec.), in which practical applications and important theoretical advances in different areas of anthropology will be discussed; and a symposium on 30 December—a total of at least eight sessions.

Psychology (I)

Section I (Frank W. Finger, University of Virginia) has scheduled the vice-presidential address of Clifford T. Morgan (University of Wisconsin) for 29 December and will have four symposia (29 and 30 Dec.) as follows: "Applications of Behavioral Technology" (Murray Sidman, Walter Reed Army Institute of Research); "The Physiology of Feeding and Drinking Behavior" (Eliot Stellar, University of Pennsylvania School of Medicine); "Concept Formation" (Roger Shepard, Bell Telephone Laboratories); and "Theories of the Visual Contrast Threshold" (Robert Boynton, University of Rochester).

Social and Economic Sciences (K)

Section K (Donald P. Ray, George Washington University), the American Political Science Association, and the National Institute of Social and Behavioral Science will jointly sponsor a symposium (27 Dec.) on "Some Perspectives on Political Science and Science." The speakers will be Robert A. Dahl (Yale University) who will discuss bases of local political influence in a democracy; Wallace S. Sayre (Columbia University) who will speak on scientists and American science policy; and Pendleton Herring (Social Science Research Council), who will deliver the vice-presidential address of Section K.

In addition, Section K will sponsor sessions for contributed papers in the social and economic sciences (30 and 31 Dec.) and will cosponsor appropriate programs of the K series and a program of the Institute of Management Sciences. These programs are arranged so that, with few exceptions, sessions are not concurrent.

The *American Economic Association* (Kenneth E. Boulding, University of Michigan) will have a group of invited papers, cosponsored by Section K (26 Dec.). These are scheduled early so that AEA members may attend both the AAAS meeting and their national meeting, to be held 28–30 December in St. Louis.

The *American Political Science Association* (Evron M. Kirkpatrick, APSA) will have a special program (27 Dec.) cosponsored by Section K.

The *American Society of Criminology* (Donal E. J. MacNamara, New York Institute of Criminology) will sponsor a luncheon with speakers and four groups of invited papers on various aspects of scientific criminology and penology.

The American Sociological Association (Mrs. Matilda Riley, Washington Square College, New York University) will probably have two different symposia (28 and 29 Dec.), cosponsored by Section K.

It is anticipated that the *American Statistical Association* (Donald Riley, ASA, Washington, D.C.) will have two sessions of particular interest to local statisticians, similar to their successful special meetings with the AAAS in Washington and Chicago. Their program will be cosponsored by Section K.

Details of the programs of the *Metric Association* (J. T. Johnson, 694 West 11th Street, Claremont, Calif.) and of the *National Academy of Economics and Political Science* (Amos E. Taylor, Parkton, Md.) will be announced later.

History and Philosophy of Science (L)

The program of Section L (John W. Streeter, Chester Springs, Pa.) (27–30 Dec.) will be coordinated with the programs of the History of Science Society and the Society for the History of Technology. There will be several joint sessions and cosponsorships. Section L is arranging a two-session symposium on "Scientism" (30 Dec.), which will probably be cosponsored by the Philosophy of Science Association. The vice-presidential address of the section will be given by Harry Woolf (University of Washington).

The biennial national meeting of the *History of Science Society* (Derek J. de Solla Price, Yale University) will begin (27 Dec.) with a council meeting and will continue with a session on 19th-century science and technology, to be held jointly with the Society for the History of Technology; the speakers will be Thomas Hughes (Washington and Lee University) and Arnold Daum (Indiana University Extension, Gary). The annual dinner of the society, at which the George Sarton Medal will be presented, will be followed by the George Sarton Memorial Lecture, sponsored by the George Sarton Memorial Foundation. Members of Section L and all others interested will be welcome at the lecture. On 28 December there will be a session on sociology and psychology of scientists, jointly with Section L; the speakers will be Karl W. Deutsch (Yale University) on "Sources of scientific manpower and competence: some issues for historical and political research," Bernard Barber (Barnard College) on "The scientist's resistance to scientific innovation," and Anne Roe (Harvard University) on "The psychology of scientists." Also on 28 December will be a luncheon and the address of retiring president Henry Guerlac; a session on ancient, medieval, and Renaissance science; and a meeting of the editorial board of *Isis*. A session for short papers on work in progress and the business meeting of the society are scheduled for 29 December.

The *Philosophy of Science Association* (Lewis K. Zerby, Michigan State University) will cosponsor the symposium of Section L on "Scientism" and may have sessions of its own.

A session of the *Society for General Systems Research* (Charles A. McClelland, San Francisco State College) (29 Dec.) will be concerned with "The Boundaries of Systems" and will include four or five invited papers under two subheadings: "Problems in the Identification and Location of System Boundaries" and "Functions and Performances of Boundaries in Certain Systems." There will be a session on 30 December for contributed papers.

The annual program of the *Society for the History of Technology*, a recent affiliate (Carl W. Condit, Northwestern University), will include a symposium on automation, cosponsored by Section L, in addition to the joint session with the History of Science Society on 19th-century science and technology.

Engineering (M)

The principal program of Section M (Clarence E. Davies, United Engineering Center Project, New York) will be the symposium "The Place of Nuclear Science Engineering in the University Curriculum," to be held jointly with Section B (Stanley S. Ballard, Universi-

ty of Florida). Section M will cosponsor the program of the Conference on Scientific Manpower.

The *Tau Beta Pi Association* (Robert H. Nagel, University of Tennessee) will sponsor an address of general interest by a prominent engineer or scientist (29 Dec.).

Medical Sciences (N)

Section N will have at least a four-session symposium (26 and 27 Dec.), with speakers and discussants coming from all parts of the country; a fifth session may be scheduled for 28 December. This year's subject, in a program arranged by Abraham Shanes (National Institutes of Health), will be "Biophysics of Physiological and Pharmacological Actions." In scope, this symposium will include "artificial and simple" animate systems that serve as models of transport; models for the study of drug interactions and of muscle contraction; the structure, biochemistry, and electrochemistry of nerves; the structure, electrochemistry, and contractile properties of skeletal, heart, and smooth muscle; and myoneural junctions. The vice-presidential address of Carl F. Schmidt (University of Pennsylvania) and the announcement of the winner of the 16th Theobald Smith Award, given by Eli Lilly and Company, will immediately precede or follow one session. Section N will also cosponsor various appropriate programs.

Alpha Epsilon Delta (Maurice L. Moore, national secretary) will devote its usual symposium to "Career Opportunities in Medicine, Dentistry, and Related Health Fields." This session will be held 29 December and will be folowed by the annual luncheon during which someone of prominence will speak.

The *American Physiological Society* (Fred A. Hitchcock, Ohio State University) is planning a symposium on "Space Physiology IV," to be cosponsored by the American Astronautical Society. The most recent developments in this fast-moving field will be presented.

The *Committee on Research, American Psychiatric Association* (Peter H. Knapp, Boston University School of Medicine) will sponsor its customary four-session program with the AAAS, to be devoted, this year, to "Expression of the Emotions in Man"—a symposium on the methods of studying, and the psychological classification of, emotional phenomena. Subtitles and content of the four sessions (cosponsored by Section I and the American Psychoanalytic Association) are: (29 Dec.) "Historical and Developmental Aspects"—a historical review and summary of phylogenetic and ontogenetic aspects of emotional expression; "Emotional Communication: Methods of Study"—a discussion of methods for the analysis of expressive phenomena; (30 Dec.) "Emotional Communication in the Clinical Setting"—utilization of psychotherapeutic interviews and the role of the empathic observer; and "Toward a Classification of Emotional Phenomena"—contributions of the psychoanalyst, neurophysiologist, and social scientist.

Among the participants will be Henry W. Brosin, René A. Spitz, P. MacLean, Roy Schafer, Ray L. Birdwhistell, George F. Mahl, M. Reiser, Felix Deutsch, Joseph G. Kepeks, D. Hamburg, Margaret Mead, and George L. Engel.

Dentistry (Nd)

Section Nd (Earl O. Butcher, School of Dentistry, New York University) will have a symposium, "The Fundamentals of Keratinization" (30 Dec.), with a luncheon between the morning and afternoon sessions. The program of the section will be cosponsored by the *American College of Dentists*, the *American Dental Association*, and the *International Association for Dental Research, North American Division*.

Pharmacy (Np)

The three-day program of Section Np (John E. Christian, Purdue University) includes sessions for contributed papers in hospital pharmacy and the section's dinner and vice-presidential address by Joseph V. Swintowsky (Smith, Kline and French Laboratories, Philadelphia) (27 Dec.); two other sessions for papers (29 and 30 Dec.); and a two-session symposium, "The Scientist's Contribution to the Safe Use of Cosmetics" (29 Dec.).

Section Np's entire program will be cosponsored by the *American Association of Colleges of Pharmacy, American College of Apothecaries, American Society of Hospital Pharmacists, American Pharmaceutical Association*, Scientific Section, and the *National Association of Boards of Pharmacy*.

Agriculture (O)

Section O (Firman E. Bear, Rutgers University) will have a six-session symposium on "Land Zoning in Relation to Agricultural, Suburban, Industrial, Forest, and Recreational Needs of the Future" (27–30 Dec.). Among the subjects and speakers are the following. (27 Dec., morning) "Rural Land Zoning," Wallace D. Bowman (Conservation Foundation) presiding: "Misuse of land—a national disgrace," Donald A. Williams (Soil Conservation Service, USDA); "Principles of rural land zoning," Earl B. Solberg (Agricultural Research Service, USDA); "Creating Permanent agricultural reserves," Karl J. Belser (Santa Clara County planning specialist, Civic Center, San Jose, Calif.); "Tax deferrals for land withheld from development," T. W. Schulenberg (State Department of Commerce, Indianapolis). (27 Dec., afternoon) "Suburban Planning," Louis Wolfanger (Michigan State University) presiding: "Subdivision control," Hugh Pomeroy (Westchester County Department of Planning, White Plains, N.Y.); "Soil-survey information for suburban development," C. S. Coleman (Soil Conservation Service, Fairfax, Va.); "New concepts on suburban development districts," Marion Clewson (Resources for the Future, Inc., Washington, D.C.); "Regulating flood-plain development," Gilbert F. White (University of Chicago). (28 Dec.) "Urban Renewal"; a joint program with sections E–Geology and Geography, K–Social and Economic Sciences, and P–Industrial Science is being developed. (29 Dec., morning) "Community Planning," Byron E. Munson (Ohio State University) presiding: "Small-city community planning," Herbert H. Smith (Community Planning Associates, Trenton, N.J.); "Large-city community planning," George H. Smeath (Planning Commission Salt Lake County, Salt Lake City, Utah); "County and regional planning board cooperation," Luther Gulick (Institute of Public Administration, N.Y.); "Possibilities in rural planning," Sanford Farness (Tri-County Regional Planning Commission, Lansing, Mich.). (29 Dec., afternoon) "Forest and Recreational Planning": "Biological requirements of man," Paul B. Sears (Yale University); "Conservation of open spaces," Charles Eliot (Harvard University); "Program planning and legislation for recreation," E. C. Crafts (U.S. Forest Service, Washington, D.C.); "Development of water and forest preserves," Raleigh Barlowe (Michigan State University). (30 Dec.) "Government as Land-Owner and Redistributor": "British Town and County Planning Act," Charles Haar (Harvard University); "Law of the open spaces," Shirley Adelson Siegel (Regional Planning Association, N.Y.); "Government land corporations," Charles Abrams (Harvard University); "Governmental help in backward rural regions," Robert Lowry (Tennessee Valley Authority, Wilson Dam).

Industrial Science (P)

Section P (Allen T. Bonnell, Drexel Institute of Technology) will cosponsor the "Urban Renewal" portion of the symposium of Section O and the symposium on management science of the Institute of Management Sciences. The address of the retiring vice president,

Earl P. Stevenson (Arthur D. Little, Inc.) will be given at the annual luncheon of the section. Another session will be the fifth Industrial Citation Dinner.

The *Institute of Management Sciences* (Merrill M. Flood, Mental Health Research Institute, Ann Arbor, Mich.) will have its second symposium on management science, cosponsored by Section P (30 Dec.); the Institute may have another session, jointly with Section K, the morning of 27 December.

It is probable that the *Society for Industrial Microbiology* will arrange a special program.

Education (Q)

The program of Section Q (Herbert A. Smith, University of Kansas) includes two joint sessions with the *Council for Exceptional Children* (26 Dec.); two sessions, joint, with the *American Educational Research Association* (30 Dec.); a symposium on machine processing (29 Dec.), probably cosponsored by the AERA and by the National Association for Research in Science Teaching, arranged by William Cooley (Harvard University); at least four sessions for contributed papers; a business meeting; and the vice-presidential address of John C. Flanagan (American Institute for Research, Pittsburgh, Pa.).

The annual national meeting of the National Association of Biology Teachers is discussed above under Biological Sciences (FG).

The four science teaching societies (ANSS, NABT, NARST, NSTA), meeting with the AAAS (coordinator, Phyllis B. Busche, Washington Square College, New York University), will have a joint session (27 Dec.) and a series of concurrent sessions similar to the coordinated program of recent years.

The *National Association for Research in Science Teaching*, it is expected, will have a research symposium. The program of the *American Nature Study Society* (Ruth E. Hopson, Portland State College, Portland, Ore.) includes a session on the natural history resources of the New York area and the annual showing of Kodachromes (27 Dec.); a session at the American Museum of Natural History and a session on "Pet Nature Projects" (28 Dec.); a tour of the Brooklyn Botanic Garden, jointly with NABT, and a business meeting (29 Dec.); sessions on "Techniques in Nature Photography" and "Illustrating Nature Books" and the annual ANSS banquet (30 Dec.).

Following two meetings of the Executive Committee (26 Dec.), the regional meeting of the *National Science Teachers Association* (Margaret J. McKibben, NSTA, Washington, D.C.) will be held. This will consist of a five-session symposium, "The New Science—A Teacher Challenge," in which the speakers will be authorities in their scientific fields. The titles of the individual sessions are "Earth Science" and "Weather" (27 Dec.); "Chemistry" and "Biochemistry of Behavior" (29 Dec.); and "Astronomy" (30 Dec.). A session on NSTA affairs is scheduled for 28 December.

Science in General (X)

A number of organizations, too general in their interests to be placed in any sectional series or under any specific discipline, will constitute the "X series" in the General Program. In this preliminary synopsis of the eighth New York meeting, the programs of many of these—the Academy Conference, the American Council on Women in Science, the Conference on Scientific Communication, and the Conference on Scientific Manpower—have already been mentioned under "Other General Events," and thus will not be repeated here.

The *American Geophysical Union*, under the auspices of its Planetary Sciences Committee, will sponsor a program of one or more sessions on space science, arranged by Homer Newell and Robert Jastrow (National Aeronautics and Space Administration).

The regular annual meeting of the *National Association of Science Writers* (Earl Ubell, New York *Herald Tribune*) with the AAAS will include a business session and dinner. A feature of the latter will be the second awards of the new series of the AAAS–George Westinghouse Science Writing Awards for excellence in science writing in newspapers and magazines.

The national convention of the *Scientific Research Society of America* (Donald P. Prentice, Yale University) is scheduled for 29 December. The award of the William Procter Prize and the annual RESA address will follow the joint luncheon with the Society of the Sigma Xi.

The national meeting of *Sigma Delta Epsilon*, graduate women's science fraternity (Mrs. Ethaline Cortelyou, Aeroprojects, Inc., West Chester, Pa.), includes cosponsorship of the third conference of the American Council on Women in Science, on encouraging the participation of women in science, and a business meeting (27 Dec.); a luncheon for women in science (28 Dec.); and the annual dinner and grand chapter meeting (29 Dec.). A headquarters room will be maintained throughout the meeting period.

The 61st annual convention of the *Society of the Sigma Xi* (Thomas T. Holme, Yale University) will be held on 29 December, following the joint luncheon with RESA. In the evening the Society of the Sigma Xi will join with the *United Chapters of Phi Beta Kappa* (Carl Billman, Phi Beta Kappa) in sponsoring an address by a prominent scientist. Since their inauguration in 1922, these distinguished lectures, of interest to all participants, have been special sessions of the Association.

Call for Papers by AAAS Sections

Six sections of the Association will arrange sessions for contributed papers at the New York meeting. The secretaries or program chairmen to whom titles and abstracts should be sent, *not later than 30 Sept.*, follow:

C–CHEMISTRY. S. L. Meisel, Socony Mobil Oil Company, Paulsboro, N.J.

G–BOTANICAL SCIENCES. Barry Commoner, Henry Shaw School of Botany, Washington University, St. Louis 5, Mo.

H–ANTHROPOLOGY. J. L. Giddings, Brown University, Providence 12, R.I., or Eleanor Leacock, The City College, New York 31, N.Y.

K–SOCIAL AND ECONOMIC SCIENCES. Donald P. Ray, Hall of Government, George Washington University, Washington 6, D.C.

NP–PHARMACY. John E. Christian, School of Pharmacy, Purdue University, Lafayette, Ind.

Q–EDUCATION. Herbert A. Smith, U.S. Office of Education, Room 5919, General Services Administration Building, Washington 25, D.C.; (after 15 Aug.) University of Kansas, Lawrence, Kan.

Although the deadline is 30 September, most sections, and subsequently the AAAS office, would be happy to receive titles in advance of this date.

RAYMOND L. TAYLOR
Associate Administrative Secretary

Forthcoming Events

June

15–24. International Union for Conservation of Nature and Natural Resources, Warsaw and Cracow, Poland. (H. J. Coolidge, National Research Council, Washington 25, D.C.)

15–25. Large Electric Systems, intern. conf., Paris, France. (British National Committee, Thorncroft Manor, Dorking Rd., Leatherhead, Surrey, England)

15–29. Nuclear Congress and Exhibition on Electronics and Atomic Energy, 7th intern., Rome, Italy. (Secretariat, Rassegna Elettronica, Nucleare e della Cinematografia, Via della Scrofa 14, Rome, Italy)

16–17. National Colloid Symp., 34th, Bethlehem, Pa. (B. R. Ray, Dept. of Chemistry, Washington State Univ., Pullman)

16–18. American Scientific Glassblowers Soc., 5th annual conf., Pittsburgh, Pa. (W. E. Barr, Gulf Research & Development Co., P.O. Box 2038, Pittsburgh 30)

16–18. Growth; Molecule, Cell, and Organism, intern. symp., Lafayette, Ind.

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- **U. S. Navy Electronics Laboratory at San Diego:** One of the Navy's largest organizations engaged in the research and development of radar, sonar, radio and acoustics.

*These positions are in the Career Civil Service.

(M. X. Zarrow, Dept. of Biological Sciences, Purdue Univ., Lafayette, Ind.)

17–19. American Soc. of Icthyologists and Herpetologists, Chicago, Ill. (R. Conant, Philadelphia Zoological Garden, 34 St. and Girard Ave., Philadelphia 4)

19–22. American Inst. of Chemical Engineers, Mexico City, Mexico. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York 36)

19–22. American Soc. of Mammalogists, annual, Tacoma, Wash. (B. P. Glass, Dept. of Zoology, Oklahoma State Univ., Stillwater)

19–24. American Soc. of Medical Technologists, Atlantic City, N.J. (Miss M. C. Wethington, 4221 Ann St., Saginaw 3, Mich.)

19–25. American Library Assoc., Montreal, Canada. (D. H. Clift, ALA, 50 E. Huron St., Chicago 11, Ill.)

19–25. American Soc. of Civil Engineers, Reno, Nevada. (W. H. Wisely, 33 W. 39 St., New York 18)

20–22. Medicinal Chemistry, 7th natl. symp., Kingston, R. I. (J. J. DeFeo, Dept. of Pharmacology, Univ. of Rhode Island, Kingston)

20–July 30. Mathematical Statistics and Probability, 4th symp., Berkeley, Calif. (Dept. of Statistics, Statistical Laboratory, Univ. of California, Berkeley 4)

20–22. Society for the Study of Development and Growth, 19th symp., Waltham, Mass. (L. Jaffe, Biology Dept., Brandeis Univ., Waltham 54)

20–23. Society for Applied Spectroscopy, 11th annual symp., Chicago, Ill. (H. Wilson, Continental Can Co., Inc., 7622 So. Racine Ave., Chicago 20)

20–24. American Soc. for Engineering Education, Lafayette, Ind. (W. L. Collins, Univ. of Illinois, Urbana, Ill.)

20–24. International Acad. of Pathology, London, England. (G. J. Cunningham, Royal College of Surgeons of England, London, W.C.2, England)

20–24. National Inventions Exhibition and Creativity Conf. (Cleveland Engineering Soc.), Cleveland, Ohio. (Cleveland Engineering Soc., 3100 Chester Ave., Cleveland 14)

20–26. Congress on Nuclear Energy, Rome, Italy, (Comitato Nazionale per le Richerche Nucleari, Via Belisario 15, Rome, Italy)

20–1. Air Force Missile Development Center and Univ. of New Mexico, series of seminars, Cloudcroft, N.M. (J. R. Foote, P.O. Box 1053, Holloman AFB, N.M.)

22–24. Standards and Electronic Measurements, conf., Boulder, Colo. (J. F. Brockman, National Bureau of Standards, Boulder)

22–25. Society of Nuclear Medicine, Estes Park, Colo. (T. P. Sears, V.A. Hospital, Denver 20, Colo.)

25–5. First Intern. Cong. on Automatic Control, Moscow, U.S.S.R. (R. Oldenburger, Mechanical Engineering Dept., Purdue Univ., Lafayette, Ind.)

26–1. American Physical Therapy Assoc., Pittsburgh, Pa. (Miss J. Bailey, 157 N. 79 St., Milwaukee 13, Wis.)

26–1. American Soc. for Testing Materials, Atlantic City, N.J. (R. J. Painter, 1916 Race St., Philadelphia 3, Pa.)

26–1. Mass Spectrometry, 8th annual, Atlantic City, N.J. (V. H. Dibeler, National Bureau of Standards, Washington 25)

26–1. National Education Assoc., Los Angeles, Calif. (W. G. Carr, 1201 16 St., NW, Washington 6)

26–2. American Physical Therapy Assoc., Pittsburgh, Pa. (Miss L. Blair, 1790 Broadway, New York 19)

27–29. Military Electronics, 4th natl. conv., Washington, D.C. (C. M. Crenshaw, Dept. of Army, Office of the Chief Signal Officer, R. & D. Division, SIGRD-2, Washington 25)

27–29. Status of Problems of Molecular Structure, symp., Seattle, Wash. (P. C. Cross, Dept. of Chemistry, Univ. of Washington, Seattle 5)

27–30. Coherence Properties of Electromagnetic Radiation, conf. (by invitation), Rochester, N.Y. (E. Wolf, Optics Institute, Rochester Univ., Rochester)

27–30. Institute of the Aeronautical Sciences, Los Angeles, Calif. (R. R. Dexter, IAS, 2 E. 64 St., New York 21)

27–30. National Assoc. of Power Engineers, annual conv., San Francisco, Calif. (E. J. Schuetz, NAPE, 176 W. Adams St., Chicago 3, Ill.)

27–1. International Assoc. for Bridge and Structural Engineering, 6th cong., Stockholm, Sweden. (P. Lardy, IABSE, Ecole Polytechnique Fédérale, Zurich, Switzerland)

27–1. Reading Conf., 2nd annual, Syracuse, N.Y. (R. A. Kress, Reading Center, Syracuse Univ., Syracuse 10)

28–1. American Home Economics Assoc., Denver, Colo. (Miss M. A. Warren, School of Home Economics, Univ. of Oklahoma, Norman)

29–1. Health Physics Soc., 5th annual, Boston, Mass. (E. E. Anderson, Health Physics Div., Oak Ridge National Laboratory, Oak Ridge, Tenn.)

July

3–5. American Assoc. of Colleges of Pharmacy, Boulder, Colo. (G. L. Webster, College of Pharmacy, Univ. of Illinois, Chicago 12)

4–8. Polarization Phenomena of Nucleons, symp., Basle, Switzerland. (K. P. Meyer, Physikalisches Institut der Universität Basel, Klingelbergstr. 82, Basle)

5–9. Goiter Conf., 4th intern., London, England. (J. C. McClintock, 149½ Washington Ave., Albany 10, N.Y.)

6–15. Entomological Conf., 7th Commonwealth, London, England. (Commonwealth Inst. of Entomology, 56 Queen's Gate, London, S.W.7)

10–14. Pan American Tuberculosis Cong., 12th, Bahia, Brazil. (F. D. Gómez, 26, de Marzo, 1065, Montevideo, Uruguay)

11–12. Response of Materials to High Velocity Deformation, conf., Estes Park, Colo. (AIME, 29 W. 39 St., New York 18)

11–15. British Dental Assoc., annual, Edinburgh, Scotland. (Secretary, British Dental Assoc., 13 Hill St., Berkeley Sq., London, W.1, England)

11–15. Royal Medico-Physiological Assoc., annual, London, England. (A. B. Monro, 11 Chandos St., Cavendish Sq., London, W.1)

11–18. Earthquake Engineering, 2nd world conf., Tokyo and Kyoto, Japan. (K. Muto, Organizing Committee, 2nd World Conf. on Earthquake Engineering, Science Council of Japan, Ueno Park, Taito-ku, Tokyo)

11–22. Grassland Cong., 8th intern., Reading, Berks, England. (British Grassland Soc., Grassland Research Inst., Hurley, North Maidenhead, Berks)

15–22. Mycology, 6th Commonwealth conf., London, England. (Commonwealth Mycological Inst., Ferry Lane, Kew, Surrey, England)

18–22. International Conf. on Congenital Malformations, London, England. (S. E. Henwood, Intern. Medical Congress, Ltd., 120 Broadway, New York 5)

18–22. Peaceful Application of Nuclear Energy, 3rd Inter-American symp., Petropolis, Rio de Janeiro, Brazil. (J. D. Perkinson, Jr., Inter-American Nuclear Energy Commission, c/o Pan American Union, Washington 6)

18–23. Endocrinology, 1st intern. cong., Copenhagen, Denmark. (G. Pincus, 1st Intern. Cong. of Endocrinology, Worcester Foundation, Shrewsbury, Mass.)

18–25. French Assoc. for the Advancement of Science, 79th cong., Grenoble. (Association Française pour l'Avancement des Sciences, 28 rue Serpente, Paris 6°)

19–22. International Conf. on Scientific Problems of Crop Protection, Budapest, Hungary. (Z. Király, Research Inst. for Plant Protection, Budapest)

21–27. Medical Electronics, 3rd intern. conf., Olympia, London, England. (Secretary, Institution of Electrical Engineers, Savoy Pl., London, W.C.2)

23–28. Otolaryngology, 7th intern. cong., Paris, France. (H. Guillon, 6, avenue MacMahon, Paris, 17°)

24–19. Modern Physical Theories and Associated Mathematical Developments, Boulder, Colo. (K. O. Friedricks, New York Univ., 25 Waverly Pl., New York, N.Y.)

25–6. International Assoc. of Physical Oceanography, 13th general assembly, Helsinki, Finland. (B. Kullenberg, c/o Oceanografiska Institutet, P.O. Box 1038, Goteborg 4, Sweden)

26–28. Poliomyelitis, 5th intern, conf., Copenhagen, Denmark. (S. E. Henwood, International Poliomyelitis Congress, 120 Broadway, New York 5)

27–12. Mathematical Statistics and Probability, symp., Berkeley, Calif. (A. P. Burroughs, Air Force Office of Scientific Research, Presentations Div., Research Information Office, AFOSR/USAF, Washington 25)

28–29. Computers and Data Processing, 7th annual symp., Estes Park, Colo. (W. H. Eichelberger, Denver Research Inst. Univ. of Denver, Denver 10, Colo.)

30–6. Institute on Religion in An Age of Science, 7th annual conf., Star Island, N.H. (R. Burhoe, American Acad. of Arts and Sciences, 280 Newton St., Brookline 46, Mass.)

31–5. Alcohol and Alcoholism, 26th intern. cong., Stockholm, Sweden. (A. Tongue, Bureau International contre l'Alcoolisme, Case Gare 49, Lausanne, Switzerland)

31–5. Photobiology, 3rd intern. cong., Copenhagen, Denmark. (A. Hollaender, Biology Div., Oak Ridge Natl. Laboratory, Oak Ridge, Tenn.)

31–6. Psychology, 16th intern. cong., Cologne, Germany. (Prof. Undeutsch, Psychology Inst. Universität, Cologne)

New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither Science *nor the writer assumes responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to the manufacturer. Include the department number in your inquiry.*

■ POLYETHYLENE CLOSURES for test and centrifuge tubes feature outer skirt that performs a number of functions, including prevention of chipping of lipped tubes, prevention of contamination by dust, prevention of throwdown of the closure into the tube when centrifuging. Sizes are available to fit all tubes of American manufacture. (Aloe Scientific, Dept. Sci.552, 5655 Kingsbury Blvd., St. Louis 12, Mo.)

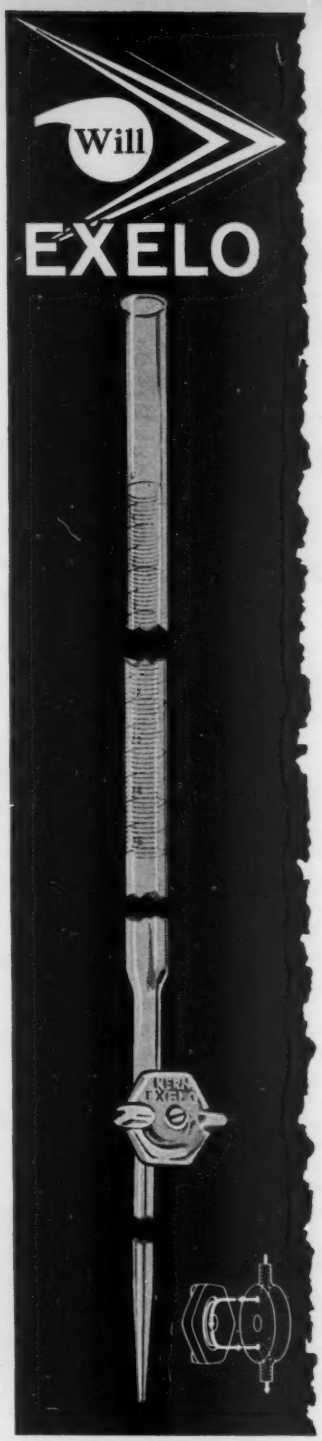
■ ATTENUATORS are offered in six waveguide sizes from 2.6 to 18 kMcy/sec with nominal attenuations of 10 or 20 db. Attenuation accuracy is said to average better than ±0.4 db from nominal with variation across the band less than 0.5 db from the mean. Standing-wave ratios are 1.05 to 1. Attenuation is a function of coupling-hole array. (Hewlett-Packard Co., Dept. Sci555, 275 Page Mill Rd., Palo Alto, Calif.)

■ STRIP-CHART RECORDER has a claimed sensitivity of 0.05 percent and accuracy ±0.2 percent. Range of 5 mv to 100 volts is covered in ten steps or by vernier for continuous span-voltage adjustment. Input resistance is 200,000 ohm/volt through 10 volts and 2 megohms on higher ranges. Full-scale response times as short as 0.25 sec are available. Six chart speeds range from 2 to 60 in./min. (F. L. Moseley Co., Dept. Sci559, 409 N. Fair Oaks Ave., Pasadena, Calif.)

■ CABLE-FAULT LOCATOR is a portable bridge that locates open conductors, shorts, grounds, high-resistance faults, crosses, and split pairs in insulated cable. A transistorized 100 cy/sec tone source provides excitation, and a high-gain tuned amplifier is used for null detection. (Whitney Blake Co., Dept. Sci562, New Haven 14, Conn.)

■ HYDROGEN ANALYZER is of hot-extraction type with operating temperature of 1200°C. Outgassing of a crucible is eliminated by use of an inert blank-free susceptor. Samples can be loaded and removed, one at a time, without breaking the vacuum. Extraction time is 3 to 10 min. (Laboratory Equipment Corp., Dept. Sci565, St. Joseph, Mich.)

■ OPTICAL CLARITY METER measures the low-angle forward transmittance of translucent specimens said to correlate well with visual estimates of optical clarity if the acceptance angle is very small. Source and receptor field angles



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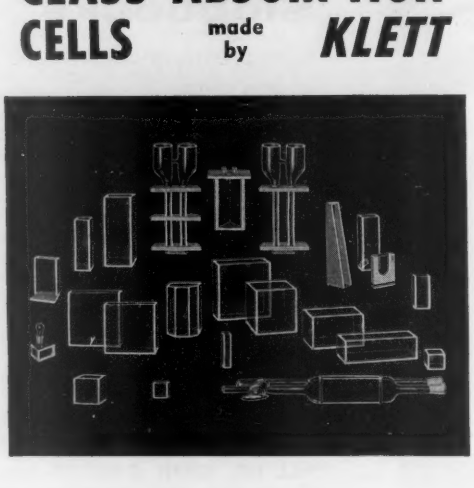

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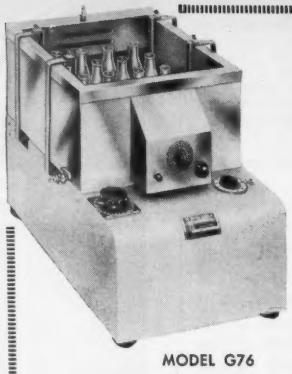

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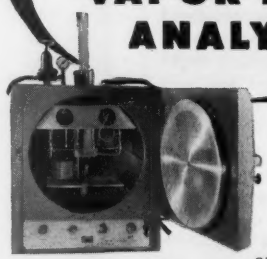

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are held below 0.2 deg. Transmitting specimens are mounted close to the instrument's projection lens either mechanically or by a vacuum-plate assembly. The instrument is designed to be used with the manufacturer's photometric unit. (Gardner Laboratory, Inc., Dept. Sci567, P.O. Box 5728, Bethesda 14, Md.)

■ PORTABLE TIME SOURCE is said to be accurate to approximately ±16 sec/yr. The instrument combines a battery-operated d-c clock with a transistor radio receiver designed to receive time signals broadcast by station WWV at 2, 5, or 10 Mcy/sec. Output of the receiver is fed to a decoder that eliminates all signals except the 1-second tick. The latter is applied to generate a pulse for synchronization of the clock. Output switching function signals are provided at 15, 30, 45, or 60 sec and at multiples of 5 min intervals up to 1 hr. Several months of operation are provided by self-contained batteries. (Zenith Radio Corp., Dept. Sci564, 6001 W. Dickens Ave., Chicago 39, Ill.)

■ STAINLESS-STEEL GAGE BLOCKS have hardness Rockwell C 68 to 70 and are said to resist nicking and burring four times better than steel blocks. Temperature coefficient is 5.75 μin./in. °F. Decimal sizes are available from 0.050 to 4.000 in., fractional sizes from 1/16 to 7/64 in. Accuracies quoted are: grade AA, ±0.000002 in.; grade A+, +0.000005 in., −0.000002 in. (DoAll Co., Dept. Sci560, Des Plaines, Ill.)

■ AUTOMATIC BURETTE FILLER can be used with standard 5-, 10-, 25-, or 50-ml open-top side-filling burettes and with any electrically conductive titrant. Pushing a button on a control box allows titrant to flow into the burette; the flow stops automatically when the titrant reaches a stainless-steel wire sensing probe placed at the zero level. No drains or overflow traps are required. (Coleman Instruments, Inc., Dept. Sci563, 42 Madison St., Maywood, Ill.)

■ SWITCHING TRANSISTOR is a silicon *npn* device said to have an average turn-on time of 4 mμsec while switching 40 watts peak power with an average power dissipation of 250 mw. Operating temperature ranges to 125°C. Parameters include emitter cutoff current varying from an average of 0.01 mμa to a maximum of 1.0 μa and avalanche voltage and collector to emitter voltage varying from 40 to an average of 70 volts. (Raytheon Co., Dept. Sci568, 215 First Ave., Needham Heights, Mass.)

JOSHUA STERN
National Bureau of Standards, Washington, D.C.

Letters

Aslib

Please permit me to point out an error in your amusing editorial "Claim to fame" [*Science* **131**, 1339 (6 May 1960)]. The abbreviation *Aslib* does not stand for "Association of Scientific Libraries" but stands for "Association of Special Libraries and Information Bureaux" and is therefore an abbreviation of the "pronounceable classic" rather than of the "hybrid" type.

KURT GINGOLD
Central Research Division, American Cyanamid Company, Stamford, Connecticut

We Are for Extensive Contacts between Scientists

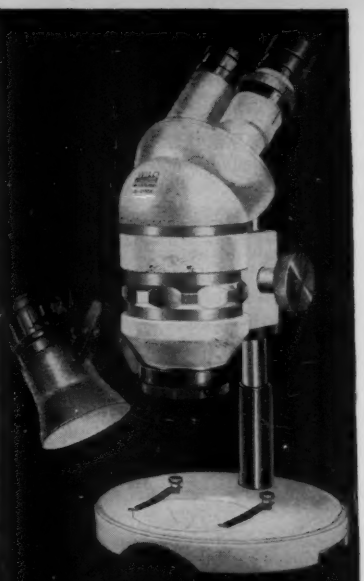
For almost 30 years I have been working at the Botanical Institute of the U.S.S.R. Academy of Sciences, where I head the department of plant taxonomy and geography.

Our Botanical Institute possesses the world's second-largest collection of plants, consisting of some 5 million herbarium mounts. Botanists from all over the Soviet Union and from many foreign countries come to work at our institute. Not long ago, for instance, several German scientists were here, while now we are playing host to Swedish scholars.

We maintain cordial relations with the famous British botanical garden, Kew Garden, and the Botanical Society of Edinburgh, which has honored me by electing me to honorary membership.

I am happy to note that our contacts with the United States have expanded markedly. We are receiving more and more letters and parcels from research establishments in New York, Missouri, Massachusetts, Iowa, and other states. Recently I received a letter from Leslie A. Garay, curator of the herbarium of Harvard University, thanking us for herbarium material and informing us that he was incorporating the data supplied in a monograph he was writing. For my part, I have just sent a letter of thanks to Dr. Lawrence of Ithaca, who presented me with a very valuable and well-compiled book, *The Taxonomy of Plants*, which we are using in our work. All this is very gratifying. But our exchange with the United States so far is characterized by thousands of herbarium mounts a year, while I recall that before the war it was much more extensive. We can and should expand our contacts.

We exchange plants, sending and receiving them for temporary use in sci-



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entific research, with more than 20 countries. But, unfortunately, there still are countries whose flora interests us, but with whom we have no contacts because of the cold war.

My colleagues and I followed with great interest the historical meeting between Nikita Khrushchov and President Eisenhower, and we are happy to see that a thaw has set in. It is as necessary to science for its growth and development as it is to plants. That is why we stand for complete disarmament, for friendship among peoples, and for broad contacts between scientists.

BORIS SHISHKIN

Botanical Institute,
Academy of Sciences of the Union of Soviet Socialist Republics, Moscow

Assay of β-Glucuronidase

We have noted with interest the reports concerning the effect of solvents on the activity of mammalian and bacterial β-glucuronidase [Gautney, Barker, Hill, *Science* **129**, 1281 (1958); Smith and Bongiovanni, *ibid.* **131**, 101 (1960); Ryan and Mavrides, *ibid.* **131**, 101 (1960)]. Two or more years ago we experienced difficulty in assaying Sigma Chemical Company's bacterial β-glucuronidase and arriving at the indicated unitage per gram. We pursued this problem not simply as a matter of analytic technique but also as a matter of simple economics, since we were assaying the enzyme at about 25 percent of its supposed activity. Sigma's laboratories assisted us in resolving our difficulties and, eventually, in understanding the discrepancies through the publication of their bulletin [Sigma Chemical Co., "Urgent Bulletin re Bacterial Glucuronidase" (Nov. 1958)]. It may be seen from this bulletin and from the reports published in *Science* that a tremendous variation is possible in "units of activity" per gram of enzyme, depending upon the technique by which the unit figure is derived. We feel that the following pertinent comments should be made.

In the assay of β-glucuronidase, the unit of activity is defined as the amount of enzyme which will liberate 1 microgram of phenolphthalein from phenolphthalein glucuronide in 1 hour *under specified conditions*. Altering these conditions in any slight degree, as is done by the addition of chloroform to retard bacterial action, may change the apparent assay by several hundred percent. This great variability in activity makes it impossible to accept, as absolute, the figures which are reported in publications dealing with the hydrolysis of urinary steroid conjugates. Unless the exact technique of assay is known, unit values for enzyme added to urine have little meaning.

It is possible, of course, to obtain maximum hydrolysis of conjugates by standardizing a batch of enzyme against a urine pool and using it empirically, as has been suggested to us by Dan Broida of Sigma. This then works, as long as an excess of enzyme is added to a urine. It is, however, not a satisfactory approach. The procedure is arbitrary. The determined maximum of enzyme for one urine may not represent a maximum for another, and every urine processed in a laboratory cannot, practically, be titrated. The method is wasteful and, needless to say, expensive. It appears to us that exact standards for the assay, to be used without alterations by those engaged in steroid work, would help eliminate at least one technical headache from this field. Undoubtedly, it would make the comparison of methods and results from one laboratory to another more valid and realistic.

ANIELA S. ZYGMUNTOWICZ
M. LOUISE BURRANS
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Research Laboratory,
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Bedford, Massachusetts

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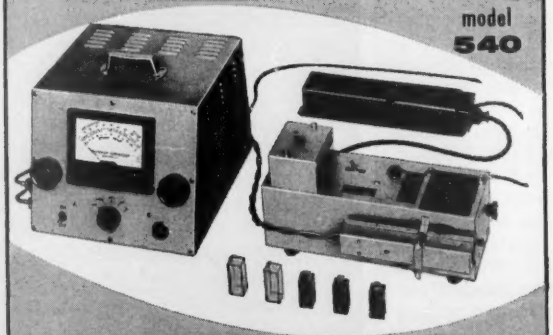

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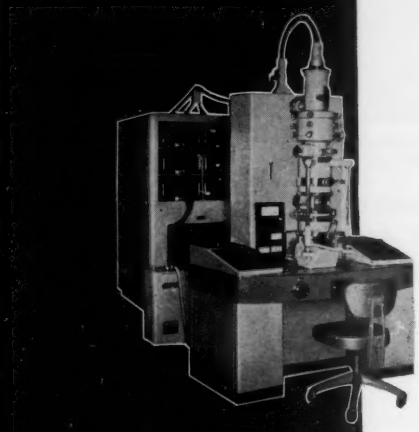

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Botanist, Microbiologist, Ph.D. interested in photomacrography and photomicrography desires position in education, industry, or research. Box 118, SCIENCE. X

Plant Physiologist, Ph.D., 31, research or teaching position. Experienced in radioisotope techniques. Box 119, SCIENCE. X

Plant Physiologist-Herbicides Ph.D., 6 years' research and supervisory experience industrial program. Box 121, SCIENCE. 6/3

POSITIONS WANTED

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M.D., American, 31. Speaks fluent German and Dutch. Desires industrial and/or managerial position with American firm operating in Europe. Presently active in general practice. Experience. Box 122, SCIENCE. X

M.D. Woman, U.S. and European degrees. Former U.S. commissioned officer. Expert in European medicine and public health. Expert knowledge of most European languages. Desires change from present long-time U.S. government position. Greater Washington area preferred. Box 116, SCIENCE. X

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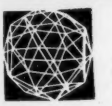

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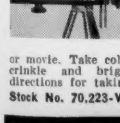

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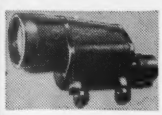

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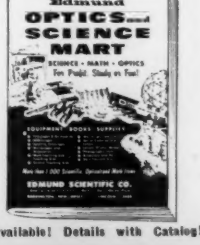

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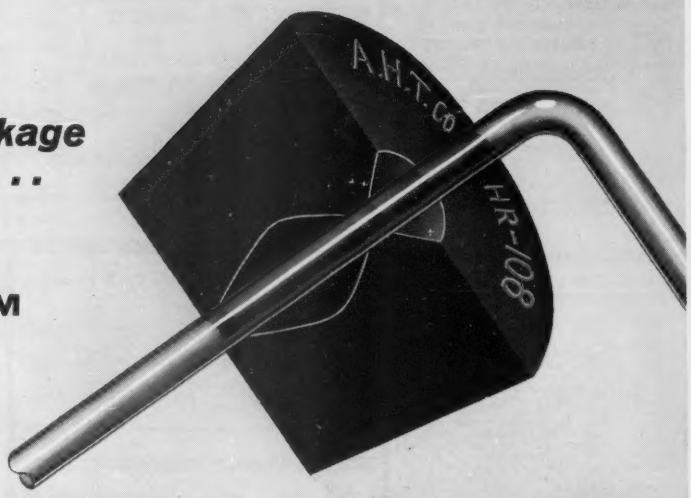

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1	97	96	1.38	10.02
2	74	72	1.48	8.07
3	55	60	1.67	7.60
4	44	48	1.81	6.60
5	37	36	2.02	5.52
5½	31	36	2.18	5.94
6	27	30	2.33	5.29
6½	24	30	2.49	5.68
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0	110	108	1.37	11.23
1	95	96	1.48	10.78
2	74	72	1.58	8.65
3	55	60	1.79	8.15
4	46	48	1.87	6.79
5	38	36	2.04	5.58
5½	33	36	2.28	6.23
6	28	30	2.42	5.52
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